

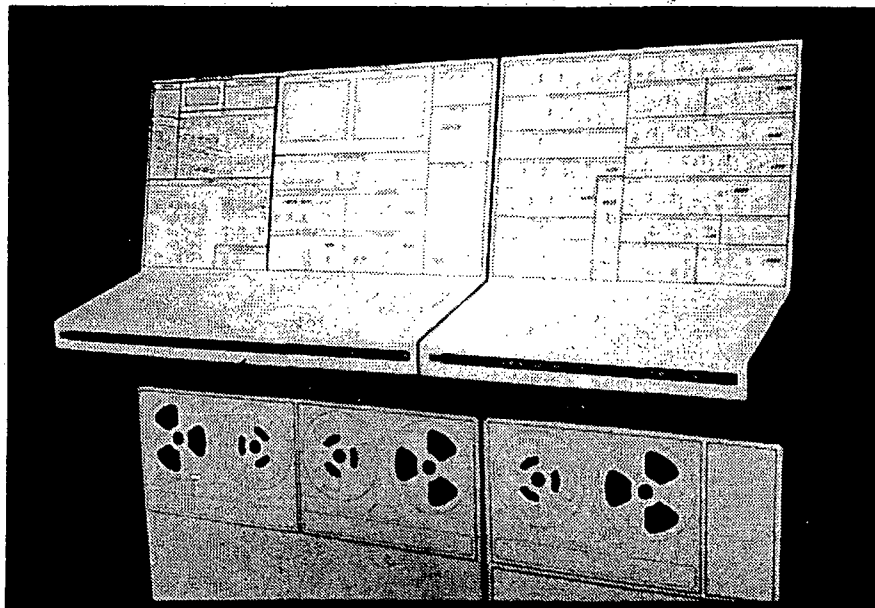
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DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATION INTERFACE REQUIREMENTS

FINAL REPORT
CONTRACT NAS8-28359

AUGUST 31, 1973



PART I

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URS/MATRIX COMPANY MAN SYSTEMS DIVISION 4702 GOVERNORS DRIVE HUNTSVILLE, ALABAMA 35805 (205) 837-4750



September 14, 1973
MTX: 73/626

Mr. Arthur W. Galzerano (S&E-S/P-T)
National Aeronautics and Space Administration
Marshall Space Flight Center, Alabama 35812

Subject: Contract No. NAS8-28359, "Development of Flight Experiment Work
Performance and Workstation Interface Requirements"; Transmittal
of Final Report

Dear Mr. Galzerano:

In accordance with the requirements of the subject contract, as amended
by Supplemental Agreement No. 3, the approved Final Report is herewith sub-
mitted. Distribution of the report is indicated on the attached distribution
list.

Sincerely,

G. Richard Hatterick
Project Director

GRH:fs

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DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS

CONTRACT NAS8-28359

FINAL REPORT - PART I

TECHNICAL REPORT
AND
APPENDICES A - G

AUGUST 31, 1973

PREPARED FOR:

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA 35812

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Project Director for the URS/Matrix Company was G. Richard Hatterick. Principal contributors from the URS/Matrix Company, Man Systems Division, to the performance of the study reported herein were Robert C. Harrison, Edwin C. Pruett, James H. LeFan, Benita C. Hayes, Estelle M. Wald, and Thomas A. Dashner.

FOREWORD

This study contract (NAS8-28359) was awarded to the URS/Matrix Company by the NASA George C. Marshall Space Flight Center to define the task performance capability requirements and to develop concepts for the experimenter workstations for selected early Shuttle Sortie missions. A further goal was to update and expand the task performance requirement/capability data base. Methodology utilized in defining task performance requirements and requisite skills for payload experiments was the "Task-Skill" technique developed under Contract NASw-2192.

Readers of this report who are closely associated with the Sortie Lab program will recognize instances where statements made, or data presented, herein are not in accord with their own knowledge of the program. Every reasonable attempt has been made to incorporate or reflect the current status of Sortie Lab definition and development. Such discrepancies are more easily understood when it is recognized that this study was initiated during the transition from the earlier baseline of "Blue Book" data, subsequently modified by RAM and SOAR studies, to what is now known as Sortie Lab. The rapidly changing environment in which experiment and payload definition studies are conducted makes such discrepancies inevitable.

This report provides a brief description of methodology, a presentation and discussion of the skill requirements for early Sortie Lab Earth Observation and Materials Sciences payloads, and the results of the analyses to define concepts for experimenter workstation configurations for these missions. It is expected that this report will have greatest utility to those involved in training and personnel resource planning, and Sortie Lab Support Module designers. It should also be useful to mission planners confronted with problems regarding payload composition.

The report is packaged in two parts:

Part I: Technical Report, with Appendices A - G containing explanatory data.

Part II: Appendix H, containing the Data Sheets resulting from the Task/Skill Requirements Analysis.

SUMMARY

Preliminary NASA studies aimed at definition of experiments and payloads for orbiting with the Space Shuttle system have included various types of crew skill requirements identification. The skill identification methods used, however, were inadequate, especially when applied to relatively undefined systems and configurations.

This study applied a skill requirement definition method (originally developed under Contract NASw-2192) to the problem of determining, at an early stage in system/mission definition, the skills required of on-orbit crew personnel whose activities will be related to the conduct or support of earth-orbital research. The experiment data base was selected from proposed experiments in NASA's Earth Orbital Research and Application Investigation program as related to Space Shuttle missions, specifically those being considered for Sortie Lab.

Activities during the study, documented in this report, include identification of basic functions dealing with man's research and/or servicing activities on orbit. A Crew Function Taxonomy was prepared relative to these activities. Likely candidate experiments for Shuttle Sortie missions were selected through extensive review of experiment and mission descriptions.

Crew functions and tasks were initially identified for more than fifty representative earth orbital experiments, and a comprehensive task analysis was conducted on these tasks for selected payloads.

Crew skill requirements for performance of three Earth Observations experiments and eight Materials Sciences experiments were identified through a technique called Task-Skill Requirements Identification. The concept and procedure of this technique, including use of the Task Dependency Reference system, is discussed, along with conversion of Task-Skills to Occupational Skill Classifications.

In addition, concepts for two integrated workstation consoles for Sortie Lab experiment operations were developed, one each for Earth Observations and Materials Sciences payloads, utilizing a common supporting subsystems core console.

A comprehensive data base of crew functions, operating environments, task dependencies, task-skills and occupational skills applicable to a representative cross section of earth orbital research experiments is presented. All data has been coded alphanumerically to permit efficient, low cost exercise and application of the data through automatic data processing in the future.

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**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

**SECTION 1.0
INTRODUCTION**

SECTION 1.0

INTRODUCTION

1.1 SCOPE AND OBJECTIVES

The contract under which the study reported herein was conducted (NAS8-28359) had three primary objectives: (1) to establish the scientific and technical task performance capabilities required for selected early Shuttle-Sortie missions; (2) to define experimenter interface concepts for two selected Sortie Lab experimenter workstations; and (3) to expand and update the existing experimenter task requirements data base. Input data to be used in achieving these objectives were the most current descriptions of experiments and missions available (including the "Blue Book", results of the RAM Phase B studies, and ongoing MSFC Sortie Lab preliminary definition studies), and the methodology developed and demonstrated by URS/Matrix under Contract NASw-2192, Development of Flight Experiment Task Requirements.

1.2 BACKGROUND

1.2.1 Early Man-in-Space

NASA's manned space flight programs during the 1960s were primarily aimed at qualifying man and machine systems for space flight and lunar exploration. In the 1970s, emphasis has changed toward utilization of manned space flight to perform research and technology experimentation in earth orbit, beyond the restrictions and constraints of the earth's atmosphere. Several such experiments were conducted in the Apollo Program, subsidiary to the primary mission of lunar exploration. The Skylab Project has gone further with experiments such as the Apollo Telescope Mount (ATM) studies of the sun, and Earth Resources studies of the surface of the earth. The primary purpose of Skylab, however, is to study the ability of man to perform effectively in space for long durations. Each of these programs, from Project Mercury through Skylab, will have added valuable knowledge about man in space, his spacecraft, the tools he needs in space, and the space environment. All of the crewmen on these missions will have been highly trained and dedicated astronauts, many having been military aircraft test pilots and some having commendable scientific credentials as well. Recent completion of the Skylab 1/2 Mission has given new evidence that man can not only perform effectively for long durations in space but also that in-space research may be severely constrained without his immediate presence.

1.2.2 Automated Research

For a number of years, automatic satellites have been gathering data on the earth-proximal space environment and making observations of the earth's surface and atmosphere from earth orbit, in addition to their use in planetary exploration. Valuable as these investigations are, they are technologically

expensive to prepare, difficult to control, and relatively inflexible in their application. Automatic satellites will undoubtedly continue to be aptly utilized for dedicated research and applications missions and/or where the environment is too hazardous for man in space. Notwithstanding the continued utilization of automatic satellites, however, it is evident that the future of in-space research will depend on extensive application of man's versatility and knowledge directly at the site of the research, i.e., in orbit.

1.2.3 Space Shuttle/Earth Orbital Research

With the Space Shuttle (now in early development and expected to be available about 1980), the United States will have the capability of placing experiment payloads in earth orbit for observation of the earth's surface, conduct of experiments and investigations regarding the space environment, or research into scientific and technological areas which capitalize on the unique characteristics of the orbital space flight environment. These experiment payloads will vary in content and purpose from small, self-contained orbital laboratories in the Shuttle cargo bay, to orbiting automated research satellites, to eventual experiment modules for a permanent orbiting Space Station. Preliminary definition studies are being conducted to identify the characteristics of the candidate experiments and the ways in which they may be grouped and/or combined into Shuttle mission payloads. Emphasis at present is being placed on the "Sortie Lab" concept, wherein experiment payloads will be housed in a special module or on a pallet carried in the cargo bay of the Shuttle Orbiter. Initial flight durations will encompass periods up to seven days; later missions may extend to thirty days or possibly longer.

1.2.4 Development of Flight Experiment Task Requirements (NASw-2192)

Just as the nature of the missions being planned has changed, the duties of the experiment personnel will be very different from those of the pre-Skylab crewmen. These duties will involve setup and maintenance of sophisticated experiment equipment, decision making and control functions regarding the conduct of experiments, and, in many instances, the interpretation of collected data. Pre-Phase A studies of experiment requirements have recognized these changes by identifying and categorizing Functional Program Elements (FPEs)* and experiments by the "skill" areas thought to be reflective of the primary purpose of the experiment and the professional discipline or occupation involved. The methods utilized to identify these skill areas were inadequate, however, when applied to relatively undefined systems and configurations. A need was recognized for a valid, flexible skill identification technique which could be

*The term "Functional Program Element" (FPE) describes a gross grouping of experiments which are each mutually supportive of a particular area of research or investigation and which impose similar or related demands on the orbiting research facility.

applied during the early stages of system definition.

In support of the new role for man-in-space, a study was performed under Contract NASw-2192 to develop the means to identify the task performance requirements of the experiment module scientific and technical crews for the conduct of the planned types of orbital experimentation. That study, based on a sampling of representative experiments, confirmed the wide variety of skills which will be needed by the crew to work successfully with the projected experiment payloads. In the conduct of the study, the URS/Matrix Company Man Systems Division successfully developed and demonstrated a technique for skill identification which is not dependent on traditional occupational titles with their inherent and frequently misleading connotations of expertise in technical and scientific areas. Rather, the technique permits identification of specific task performance requirements based on the purposes and objectives of either general or specific tasks and subtasks and the interfaces with certain items of equipment, facilities, and environmental factors. While avoiding the occupational implications during the analytical phase of determining task performance capabilities, the method retains compatibility with occupational and professional designations. This feature simplifies the early identification of candidate personnel with the most nearly correct combination of task performance capabilities. Alternatively, the skills of selected experiment crew members can be compared to skills required for a particular mission to identify specialized training which may be required. The full report of this study, published in June 1972, is included in the bibliography of this report, as References 67, 68 and 69.

1.3 DEVELOPMENT OF FLIGHT EXPERIMENT WORK PERFORMANCE AND WORKSTATIONS INTERFACE REQUIREMENTS (NAS8-28359)

Apace with the definition of experiments and systems for manned research in space, and the availability of a technique for making valid assessments of requisite crew requirements and interfaces, the current study was initiated under contract to NASA's Marshall Space Flight Center. It was recognized that in order to provide for early identification of candidate experiment scientific and technical personnel, a systematic, in-depth analysis of the requirements for scientific and technical task performance capabilities was needed, together with identification of workstation interfaces upon which these skilled experimenters would be dependent. From such identifications, performance capability requirements and criteria for flight experiment crew complements and workstation concepts capable of accomodating a wide variety of flight experiments in many different combinations could be developed.

The approach used to accomplish this task is discussed in Section 2.0 of this report. Results achieved in the identification of performance capability requirements and the definition of preliminary workstation concepts are presented and discussed in Sections 3.0 and 4.0, respectively. Section 5.0 summarizes the findings of the study, together with relevant conclusions

regarding their application to other current and planned man-in-space development efforts. In addition, recommendations are presented for follow-on efforts to make maximum and timely utilization of the data developed thus far. Explanatory and reference data are presented in Appendices A through G of this volume; Task/Skill Requirements data sheets for the experiments/payloads subjected to analysis in this study are included in Appendix H, a separate volume of this report.

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

SECTION 2.0

TECHNICAL APPROACH



SECTION 2.0

TECHNICAL APPROACH

This section of the final report presents a discussion of the approach used by URS/Matrix to achieve the objectives listed in Section 1.0, and a brief description of the method for identification of scientific and technical crew performance capability requirements.

2.1 STUDY APPROACH

2.1.1 Assumptions, Guidelines and Constraints

The major guidelines underlying the URS/Matrix program of study were as follows:

- (1) Task requirements were to be determined only for experiment-related tasks, specifically excluding such functions as were required for operation and/or maintenance of the Shuttle Booster and/or Orbiter.
- (2) Performance requirements and capabilities were to be identified for nominal modes of operation only, with no special attention to contingency or emergency modes.
- (3) Experiments/payloads to be subjected to analysis were to be selected from those defined for Shuttle-Sortie missions in the Research and Application Module (RAM) Programmatic Reference Experiment Plan (REP) in the RAM Phase B Study (Ref. 37). Subsequent to initiation of the study, it was mutually agreed between URS/Matrix and NASA representatives that the selected experiments should correlate as closely as possible with those being identified for early (1979-1982) Sortie Lab missions (Refs. 48, 49, 92, 93, 112, 119).

2.1.2 Study Plan Summary

The study plan followed by URS/Matrix emphasized maximum utilization of data from recent and ongoing experiment definition studies, as well as the preliminary task analysis conducted under a prior contract (Ref. 69). The general flow of the study is illustrated in Figure 2-1. The study was initiated by an in-depth review of available data (see Appendix A) in support of the NASA Reference Experiment Plan (REP) and the emerging Sortie Lab definition. The initial output of this effort, depicting RAM-identified payloads and missions which were potentially feasible for study, and their status relative to the existing task-skill data base, is shown in Figure 2-2. Figure 2-3 shows the results of the initial screening on the basis of the "early mission" constraint. It should also be noted that two "man-tended" payloads (i.e., free-flyers) were being considered for study in addition to Shuttle Sortie payloads. On the basis of this screening, the payloads/experiments listed in Figure 2-4 were selected for the first step of the task requirements

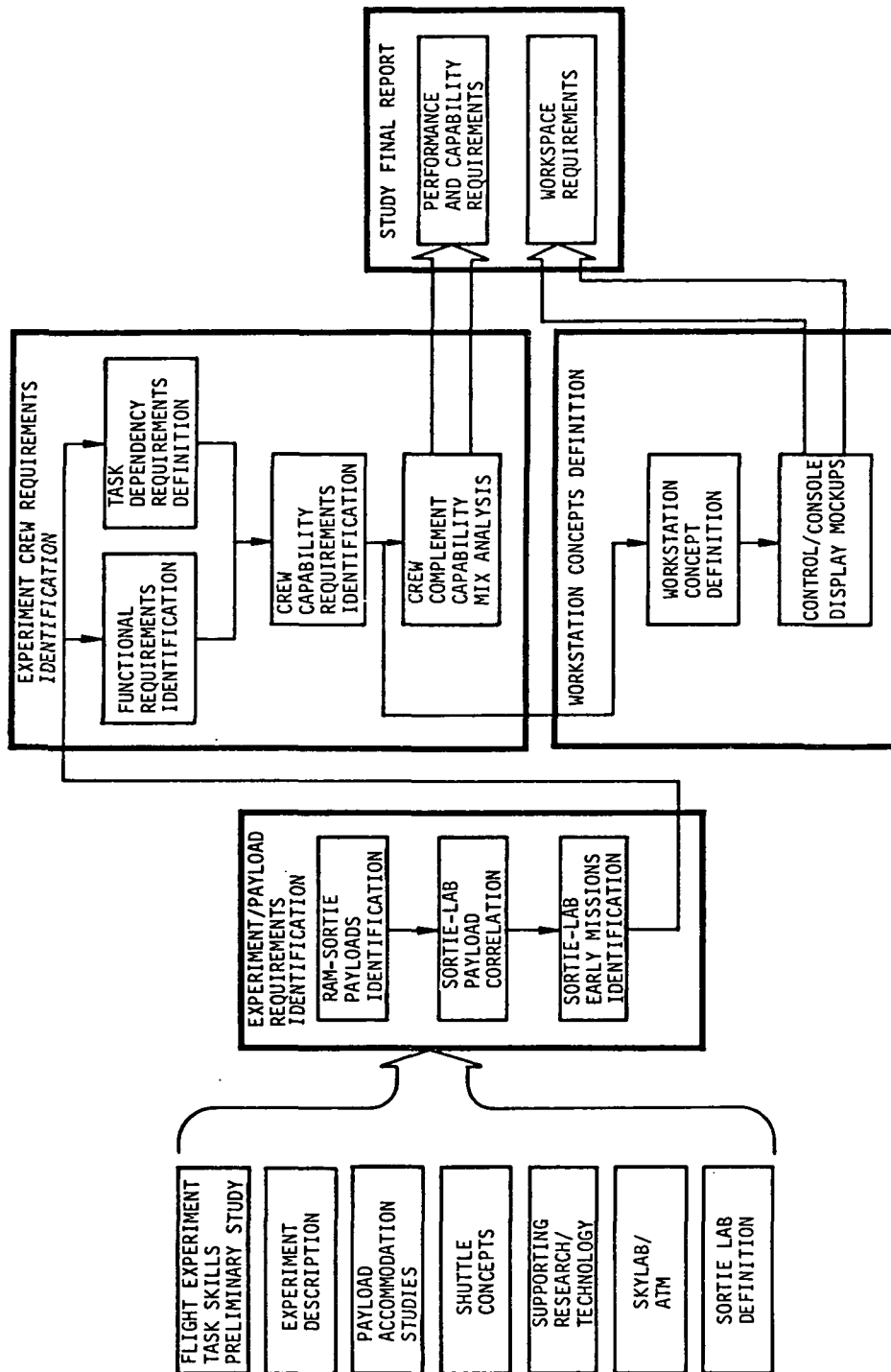


Figure 2-1: Project/Task Flows, NAS8-28359

PAYLOAD CLASS	RAM EXPERIMENT AREA	SCHEDULE & PAYLOAD NUMBER											
		78	79	80	81	82	83	84	85	86	87	88	89
MAN-TENDED OBSERVATORIES (FREE-FLYERS)	HEAO A-5 Revisits		X	A503B 2			Y		X		A503B 2		
	HEAO A-1 Revisits					X	2	A103B 2				X	A103B 1
	Large Space Telescope A-2 Revisits				X	2	A203B 2		Y		A203B 2		
	Large Solar Observatory A-3 Revisits						X	2	A303B 2			Y	A303B 2
ATTACHED TO STATION	Physics Lab												
	Cosmic Ray Lab												
	Life Sciences Lab				X	A812B Y			X		A812B Y		
	Earth Observations Lab				X	E1A2B Y			X		E1A2B Y		
	Comm/Nav. Lab						X	C1A2B Y					X
	Technology & Mgmt. Sci. Lab												
	Physics				P5S1B P5S1B	P5S2A P7S1A	P5S2A P7S2A	P5S2B P8S2B	P5S2B P8S2B	P5S2A P7S3A	P5S2B P8S2B	P5S2B P8S2B	
	Astronomy		A3S1B	A3S1B		A8S1V A8S1V	A9S1J A9S1J		A8S1W A8S1W	A8S1X A8S1X	A8S1V A8S1V	A8S1X A8S1X	
	UV								A8S1W A8S1W	A8S1X A8S1X	A8S1V A8S1V	A8S1X A8S1X	
	IR				A6S1B	A6S1B			A8S1U A8S1U	A8S1Z A8S1Z	A8S1V A8S1V	A8S1X A8S1X	
SORTIE MISSIONS	Life Sciences L8(D)LA [†]		L8S1B	L8S1B					L8S2B L8S2B				
	Earth Observations			E1S1Q P	P	R	Q	N	N	Q	Q	Q	N
	Communications/Navigation				C1S1E M1S1E	C1S1F M1S1E				C1S2C M1S1G	C1S2C M1S2B	C1S2C M1S2B	
	Materials Science												
	Technology	T-1*											
		T-2		T2S1A			T2D2B					T2S2E	
		T-3											T3S2B
		T-4											
		T-5*											

[†]BioResearch Module - Flies piggyback on applicable sortie payloads on resources - available basis at rate of 2 times/yr for the first 3 years. Two experiment modules may be delivered on same flight.

*Operational payloads for these FPEs not included on REP. ** A502D, A202B are alternates for A503B and A203B respectively.

Payloads excluded from study.

Figure 2-3: Identification of Early Missions Per RAM Programmatic REP.

identification -- the Crew Function Analysis (Correlation with Sortie Lab payloads had not yet been achieved).

With the availability of the initial definition of projected Sortie Lab payloads (Refs. 49, 112), a correlation was made between Sortie Lab payloads and those identified in RAM and Shuttle documentation as early Shuttle missions. This correlation is shown on the lower portion of Figure 2-4.

For purposes of this study, the most feasible Sortie Lab payloads to be subjected to detailed task and skills analysis were those in Earth Observations (EO), Materials Sciences and Manufacturing (MS), and Space Physics (SP). A determination was made to select the following Sortie Lab payloads for completion of the study.

Earth Observations

- EO-3 Air and Water Pollution
- EO-4 Resource Recognition
- EO-5 Disaster Assessment

Materials Sciences and Manufacturing

- MS-1 Biological Experiments
- MS-2 Levitation Experiments
- MS-3 Furnace Experiments
- MS-4 Small and Low Temperature Experiments

Using this list of reference payloads/experiments, the detailed analysis of task dependencies and skills proceeded, following the methods described in Section 2.2. As the interfaces between the scientific/technical crew members and their equipment/instrumentation were defined, concepts for the Earth Observations payload and the Materials Sciences payload control/display workstations were developed.

Results of the task/skill analysis and the workstation concept development portions of this study are presented in Sections 3.0 and 4.0 respectively.

2.2 TASK/SKILL IDENTIFICATION METHODOLOGY

The methodology used in this portion of the study was that which was developed and demonstrated under Contract NASw-2192, and which is fully described in that study's Final Report (Ref. 68). The description which follows covers only the basics, to provide potential users of the data contained in subsequent sections with sufficient understanding to permit application of the data to their particular problems.

2.2.1 Origin and Rationale of Task-Skill Methodology

Reports prepared in support of NASA's earth orbital research and applications programs had included listings of "crew skills" for the various experiment areas. Of primary importance in this respect was the NASA "Blue Book" (NHB 7150.1) (Refs. 1 through 8), which listed twenty-seven (27) crew skills required

Figure 2-4: RAM Payloads/Experiments Selected For Crew Function Analysis, With Correlation To Sortie Lab Payloads

by the composite experiment program. Descriptions within the Blue Book of areas of experimentation (usually at the FPE level) specified, on a preliminary basis, which of the "skills" were required for support, e.g., Biochemist, Astronomer, etc. It was recognized by some that these listings were not truly indicative of "skill" requirements but were merely references to the occupational and professional designations most closely associated with an area of research. It was on this premise that the need for a better method was based, initiating the NASw-2192 study.

Subsequent to the release of the Blue Book, several major definition and development studies, e.g., Shuttle Orbital Applications and Requirements (SOAR), Research and Applications Module (RAM), Life Sciences Payload Definition (LSPD), etc. released reports which also included crew skill listings. In all cases, the listings in these reports purported to be based on an analysis of personnel resource requirements, yet each case turned out to be a variation of the Blue Book listings. In no instance was any analysis documented in these reports to substantiate the crew skill listings.

To illustrate, Table 2-1 lists the "crew skills" as presented by the Blue Book, together with the listings found in various other study reports and documentation. As can be seen, there is very little difference between studies, with respect to the skill titles listed. The similarity extends, in some instances, even to the use of the same code numbers from one study to another. The LSPD list, of course, is much shorter, covering only Life Sciences research areas. Even those differences which do occur are, to a great extent, artificial, e.g., the combination of an electromechanical technician and an optical technician into electromechanical/optical technician.

Of even greater concern is the manner of specifying crew skills. Of the reports referenced herein, only the Blue Book admits that selection of some of the parameters (including skill requirements) is arbitrary. The remaining studies give the impression of analytically derived skill requirements, although these requirements are, in reality, a repeat of Blue Book data.

For example, the SOAR Final Report (Refs. 71 - 85) is comprised of many volumes devoted to presentation of requirements and recommendations for use of the Shuttle. Volume 1 (p. 20) describes how payload planning activities have to limit experiment accommodation on the Shuttle because of "crew skill" availability:

"...it was determined that an experiment crew limitation to two men had a definite effect on Blue Book payload accommodation. Over a 5-day mission, the number of sub-FPE payload elements that could reasonably be accomplished was an average of two. These generally had to be single discipline or in closely related disciplines to minimize cross-training for crew skill requirements."

In this case, payload accommodation has been limited by crew skill requirements. In tracing the source of these requirements, one is led to Volume 1, Appendix B of the report, wherein "Crew Requirements" for each payload element are given.

TABLE 2-1: Comparison of Crew Skill Listings

CREW SKILL TITLE	SOURCE AND SKILL CODES*				
	Blue Book (Ref. 1-8)	SOAR (Ref. 71-85)	RAM Phase B (Ref. 50-51)	Sortie Lab (Ref. 94)	LSPD (Ref. 51)
Biological Technician	1	●	1	14	1
Microbiological Technician	2				2
Biochemist	3		2		3
Physiologist	4				4
Astronomer/Astrophysicist	5	●	5		
Physicist	6	6	19	19	
Nuclear Physicist	7				
Photo Technician/Cartographer	8	●	8	12	
Thermodynamicist	9	9	16	12	
Electronic Engineer	10	10	14	18/16	
Mechanical Engineer	11	●	15		
Electromechanical Technician	12	12		5	12
Medical Doctor	13	●	3		13
Optical Technician	14	14		4	
Optical Scientist	15		6		
Meteorologist	16	●	10	7	
Microwave Specialist	17	17			
Oceanographer	18	●	11	6	
Physical Geologist	19	●			
Photo Geologist	20	●			
Behavioral Scientist	21		4	21	21
Chemical Technician	22		20		22
Metallurgist	23	●	17	17	
Material Scientist	24	●		15	
Physical Chemist	25	25		22	
Agronomist (Agronomer)	26	●	12		
Geographer	27	●	13	11	
Astronomer		●		1	
Physicist/Astronaut		●			
Astrophysicist		●		2	
Astronaut		●		20	
EVA Backup		●			
Pilot/Navigator		●			
Hydrologist		●		10	
Life Science Technician		●			
Geologist		●	9	9	
Electromechanical/Optical Tech.			7		
Chemist			18		
General Skill			27		0
Electrical Engineer				3	
Agronomist/Forester				8	
Cloud Physicist				13	
General Scientist				23	

*Numerals are code numbers assigned in source document.
Symbol ● indicates callout by title without code number.

The crew skills are those shown for SOAR in Table 2-1 of this report and the data in Vol. 1, Appendix B, of the SOAR report are reprinted from the MMC "Green Book" (Refs. 9, 10), which states in the introduction: "All requirements are based on the January 1971 Reference Earth Orbital Research and Applications Investigations (Blue Book)." Thus, payload accommodations in the SOAR study are constrained by occupational titles in the Blue Book, for which no clear definitions are provided.

Another example is found in the RAM Phase B Study Report (Ref. 30), Trade Study TS-1100-03, Shuttle-Supported Sortie Mission Compatibility. The objective of this study was to "develop rationale for determining experiment suitability to Shuttle-supported missions..." One of the screening criteria was crew requirements. The trade study concluded that all individual experiments are compatible with a crew of two or less, which is not surprising since the authors assumed "...for any given sortie mission, the two crewmen assigned to experiments can possess as many skills as necessary for any selected experiment." Other assumptions were equally loose, including the use of a skill assignment to experiments, such assignment obviously being based on Blue Book and Green Book data and not on actual evaluation of experiment requirements. Assumptions made regarding cross-training capability are equally unjustified.

Other program and study documentation has treated the topic of skill requirements in the same manner as discussed above. Skill requirements are being utilized in these studies -- as well they should be -- but there has been insufficient effort to determine what the actual skill requirements are. Decisions are being made based on loosely derived crew skill requirements. Evidence that the crew skill listings are merely being passed from one study to another may be found by examination of the preliminary Sortie Lab program data (Ref. 116) shown in column 4 in Table 2-1. The similarity between this list and previously published lists will undoubtedly become even greater when the Sortie Lab data is expanded to include the Life Science experiments. The well known tendency to put off the application of efforts to "personnel subsystem" factors is again in evidence.

To summarize, there is considerable evidence in published study reports that crew skills needed for on-orbit experimentation were not being determined through actual analysis of requirements. The impact of these practices, if not corrected, will be felt throughout all levels of system definition and development, as well as in the missions themselves. Provisions for the needed crew skills will greatly affect the quality and quantity of data return from each mission. Timely attention to this area of definition will often prove decisive in determining levels of automation in mission equipment, as well as weight, power, and other "engineering" parameters. Dependence on extensive cross-training of crew members is not the answer either, especially since the skills which the crew is to be trained to perform are not known. In addition, NASA has stated that these experimenters will not be astronauts but scientists from the industrial and academic communities. This will leave little opportunity to close all the skill gaps by cross-training.

Reflecting on the data presented above, it becomes obvious that in order to determine the skills that would be required, the activities and tasks generating the requirements for particular skills need analysis. Further, skills should be defined in such a way that they are independent of the connotations and associations of "accepted" occupational and professional titles. In addition, skills should be defined at a level that is independent of factors such as crew size, specific equipment configurations, mission duration, experiment grouping within the payload, or facility characteristics. This led to the concept of "task-skills". The procedural flow for accomplishing skills determination using this method is shown in Figure 2-5.

2.2.2 Task-Skill Definition

The concept, basically, is to describe the skill requirement in terms which identify a particular function (e.g., inspect, control, evaluate) which a man must perform and the item or factor (e.g., spectrometer, subsatellite, stellar data) with respect to which the function must be performed. A task-skill is, in effect, a brief phrase or description which denotes a specific equipment- or procedure-oriented crew function (e.g., Spectrometer Inspector, Subsatellite Controller, Stellar Data Evaluator).

Task-skills can be defined at any level which can be supported by the input data. Very preliminary definition can take place even before the specific types of equipment involved in a task are identifiable. For example, it may be known that an experiment on-orbit will require various types of observational equipment, and that, at some point in the mission, the equipment will need to be inspected for damage, cleanliness, etc. A general task-skill requirement can be stated immediately, e.g., Observation Equipment Inspector. Later, as the experiment becomes better defined, more specific task-skill titles can be substituted, e.g., Optical Equipment Inspector, Electronic Sensor Inspector, etc. When specific types of equipment are identifiable, these become the level of definition of the task-skill, e.g., Spectrometer Inspector, Telescope Inspector, etc. When the nature of the crew function with regard to an item of equipment is sufficiently complex and/or demanding, task-skill identification may be required at an even more specific level, e.g., Ion Mass Spectrometer Repairer. The task-skill should be defined at the lowest level which will incorporate the essence of the demands of the equipment item (or other factor) and the function to be performed on the knowledge, experience and training of the crewman.

In the preceding discussion, frequent reference has been made to "crew function" and "equipment item" in the context of task-skill development. These phrases have been formalized and incorporated in the task-skill development methodology. Crew functions are discussed in paragraph 2.2.3. The "equipment items" or other factors are called Task Dependencies, and these are discussed in paragraph 2.1.4. To complete this general discussion of the task-skill identification concept, paragraph 2.2.5 is comprised of a brief discussion of the "Operating Environment", the environment in which the crewman performs his assigned function, and paragraph 2.2.6 is a discussion of "Occupational Skills Classification", the final step of the task-skill definition technique.

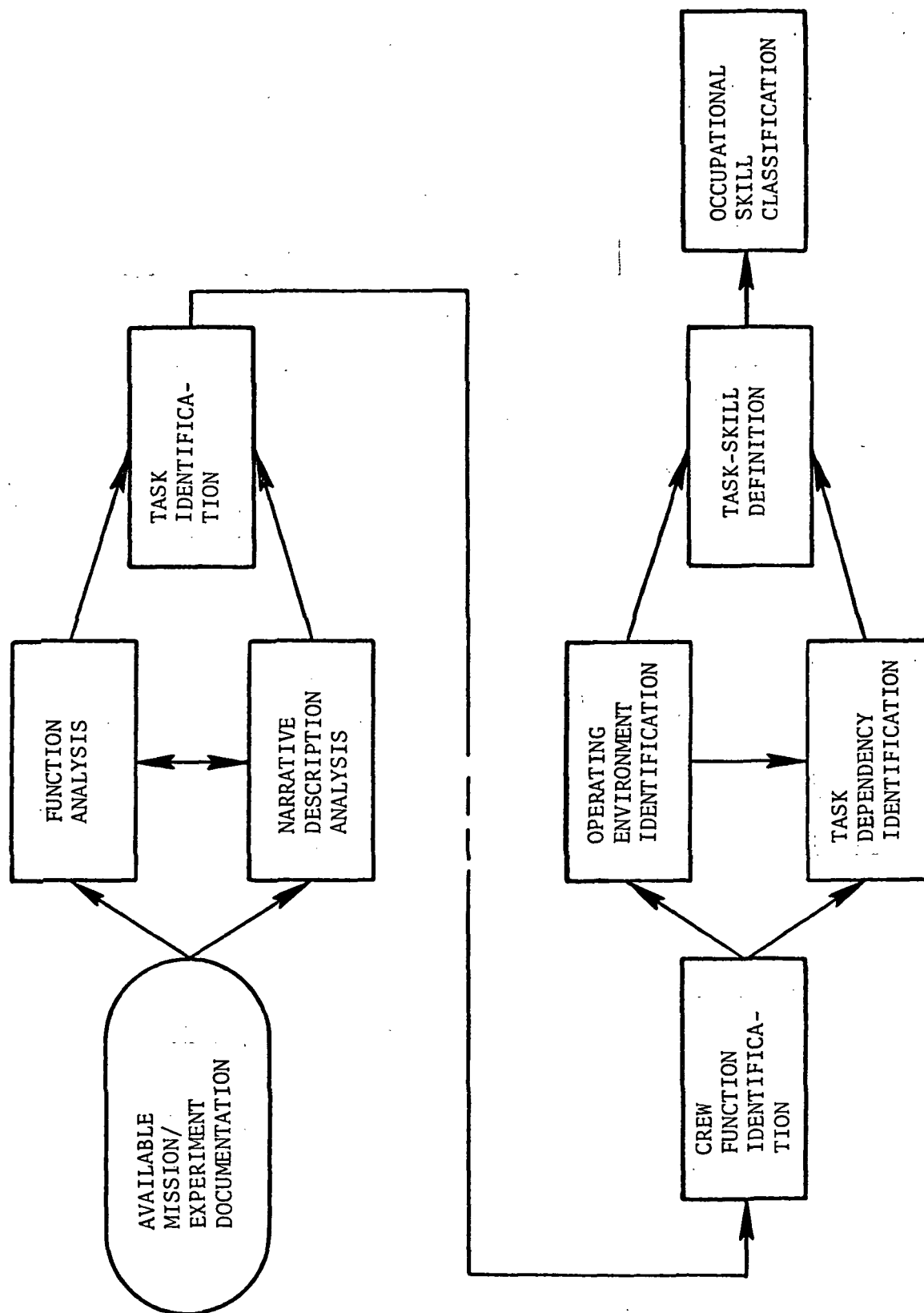


Figure 2-5: Procedural Steps for Task-Skill Requirements Identification

2.2.3 Crew Function Taxonomy

Essential to the identification of task-skills is the knowledge of the kinds of functions which a crewman is expected, or may be expected, to perform. Definition of these functions can take many forms but should, to the greatest extent possible, be mutually exclusive, provide insight to the intellectual, sensory, and/or motor activities of the crewman, and be independent of the nature of the equipment or experiment with respect to which the function is to be performed. During this study, and for purposes of utilization in the task-skill identification, the taxonomy of crew functions shown in Table 2-2 was developed. Definitions of these crew functions are included as Appendix B to this report.

Crew functions 01 through 28 were identified as being generally applicable to a wide range of experiments. Crew function 29 (Unknown) is reserved for cases where the nature of the crewman's function cannot be determined. Crew Function 30 (Subject for Experiment) is used to identify instances where a crewman's activities were being evaluated as part of experiment conduct. Crew functions 31 through 34 were assigned during the detailed analysis of Life Science experiments to cover rather unique crew functions which did not "fit" the basic crew function taxonomy. An example of a Crew Function Worksheet analysis, assigning basic functions, crew functions, and operating environments to the identified task statements, is shown in Figure 2-6. These worksheets are utilized to make a preliminary assessment of the relationships between the identified task statements and the appropriate modes of operation, basic functions, crew functions, and environments. This provides the analyst with an overview of the experiment prior to initiating the detailed task-skill requirements analyses.

TABLE 2-2: CREW FUNCTION TAXONOMY

No.	Title	No.	Title
01	Status Monitoring	18	Unstow
02	Observation	19	Clean and Decontaminate
03	Inspection	20	Assemble
04	Pattern Recognition	21	Disassemble
05	Communication	22	Translocation
06	Data Processing	23	Deployment
07	Fault Isolation	24	Retrieval
08	Calibration	25	Locomotion
09	Alignment	26	Removal
10	Control	27	Replacement
11	Evaluation	28	Repair
12	Analysis	29	Unknown
13	Decision Making	30	Subject for Experiment
14	Test and Checkout	31	Occupy
15	Actuation	32	Wear
16	Deactuation	33	Receive
17	Stow	34	Donate

Definitions of Crew Functions are included in Appendix B.

[illegible]

- (1) See Reference No. 68 for a complete explanation of the use of a Crew Function Worksheet.
- (2) Mode Applicability: A = Shuttle Sortie; B = Shuttle-Supported Free Flyer.
- (3) Explanation of "Basic Functions" is given in Appendix C of this report.
- (4) Definition of Crew Functions is given in Appendix B of this report.
- (5) Operating environments are explained in paragraph 2.2.5 of this report.

Figure 2-6: Example of Crew Function Worksheet for Experiment Tasks

2.2.4 Task Dependency Reference List (TDRL)

Within the context of task-skill identification, a "task dependency" is a factor upon which successful performance of a crew function depends. The nature of such factors covers a very broad range, and all have implications for the knowledge, training, and/or experience which must be possessed by the crewman. Any efforts to identify crew skill requirements must, of necessity, identify the factors upon which performance depends. Further, these factors, or task dependencies, must be identified at the most specific level supportable by the input data, but they must not preclude the progress of the analysis if specific identification is not possible. To achieve this goal, a determination was made of the major types of factors upon which successful performance depended. These major factors are categorized as:

1. System and Facilities
2. Experiment Equipment and Materials
3. Object or Area Under Investigation
4. Support Equipment
5. Environment
6. Mission Considerations

The six major categories of task dependencies are divided into subcategories based on major functional differences. Then, as each new item of equipment or object of investigation is identified, it is placed in one of the subcategories. Each item is given an alphanumeric code designation to permit ready recognition of the category and subcategory to which it belongs and to promote rapid data retrieval. In addition to these three levels, a fourth level is assigned, where appropriate, to identify specific equipment items or characteristics. For example, within the major category of "Experiment Equipment and Materials" (#2), the second level might be "Observation Equipment" (#2.A), and the third level of dependency could be "Spectrometers" (#2.A.03). The fourth level, then, would be various specific types of spectrometers (e.g., "Ion Mass Spectrometer"), and each type would be assigned a dash number (e.g., 2.A.03-6). An illustration of the structure and use of the Task Dependency Reference System is shown in Figure 2-7. A complete listing of all Task Dependencies identified to date (NASw-2192; NAS8-28359) is incorporated in this report as Appendix D.

The utilization of the TDRL enables the analyst to specify the equipment, environment, conditions, etc. on which task performance depends to whatever level of specificity is supportable by program definition status and/or is needed by the purpose of the analysis. There is no need to determine precise equipment characteristics or to obtain serial numbers in order to document the item's relationship to the task. In fact, an equipment item which does not yet exist can be included and can have the same consideration as those which are well defined. The TDRL further recognizes and incorporates the less tangible or less visible factors which affect task performance, (e.g., an area of knowledge) and ensures that consideration is not limited to a specific item of hardware. It is expandable, condensable, and flexible and is designed to be a tool to aid in the conduct of analyses rather than a documentation of what has transpired.

TDR
CODE

LEVEL #4

LEVEL #3

LEVEL #1
LEVEL #2

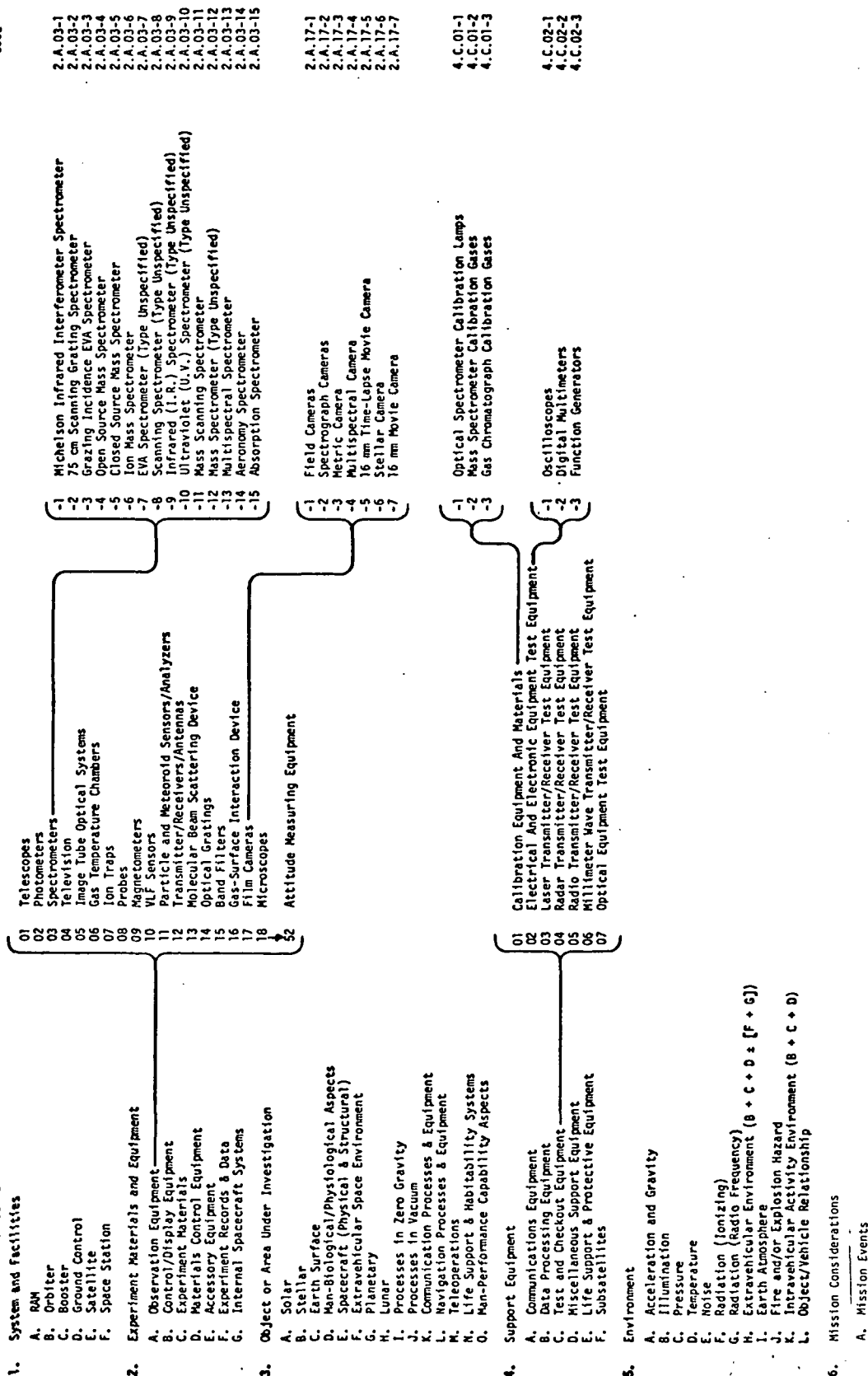


Figure 2-7: Example of Task Dependency Reference List (TDRL)

As described in paragraph 2.2.2, the title of the primary task dependency and the appropriate crew function title are combined to prepare the task-skill title. The actual procedure used for accomplishing this is fully described in Reference 68.

2.2.5 Operating Environments

The "Operating Environment" was defined in this study as the environmental conditions under which the crewman must perform his assigned functions. The purpose of this identification is twofold. First, by identifying the operating environment, constraints imposed by the environment on task performance can be identified. Secondly, identification of the operating environment provides an input to the Task Dependency Reference List, since "Environment" is one of the six major categories of dependencies (see Figure 2-7).

The analysis conducted during the original study determined that there were eight separately identifiable operating environments, as shown and defined in Table 2-3. Since all experiment module crew tasks are performed on-orbit, zero gravity was assumed to be the usual environment. For this reason, the gravitational environment was identified in the task-skill analysis only when it was other than zero gravity. The listing in Table 2-3 is not intended to be all inclusive but, rather, to account for those operating environments identified in experiments analyzed to date.

The manner of incorporation of operating environments into the task-skill requirements analysis is fully described in Reference 68. As a general rule, however, the operating environment data is used in evaluation of the task-skill characteristics, although it is not reflected in the task-skill title.

2.2.6 Occupational Skill Classification

An important feature of the Task-Skill concept discussed in the preceding paragraphs is the availability of a method by which the skill requirement identification at the task level can be realistically equated to the source of these skills for specific missions, i.e., the scientists, engineers, and technicians who will ultimately be needed to perform the on-orbit activities. An initial premise was that requirements for experiment- or mission-specific training should be held to a minimum and that the experiment crew would be selected from the scientific and technical population to provide the best "fit" to the required task-skills. Various methods of job-skill and occupational-skill definitions were evaluated, including those presently in use by the military services. As a result of those evaluations, it was decided that the broadest, most easily applied method was that being utilized by the U.S. Department of Labor. This method is described in detail in the two volume Dictionary of Occupational Titles (Refs. 20, 21) issued by the Manpower Administration of the Labor Department. The Dictionary contains titles and definitions of 21,741 separate occupations, plus 13,809 additional, or alternate, titles for those occupations. In the Dictionary, a six-digit coding system is used, with the first three digits identifying the applicable occupational group

TABLE 2-3: OPERATING ENVIRONMENT TAXONOMY AND DEFINITIONS

OPER. ENVIR. NO.	OPERATING ENVIRONMENT TITLE	OPERATING ENVIRONMENT DEFINITION
00.	<u>ZERO GRAVITY</u>	An environmental condition in which gravitational and other external forces acting on the experiment module or scientific crew member produce no stress, either internal or external; weightlessness.
01.	<u>SHIRTSLEEVE</u>	A "shirtsleeve" environment is one in which the facility housing the crew provides all the life support and temperature maintenance. There is no requirement for pressure suits or umbilical connections. Except for zero gravity or low gravity, it is a normal, earth-type environment. A further exception may be the existence of a one gas atmosphere at low oxygen pressure.
02.	<u>EVA</u> (Extravehicular Activity)	In this environment, the crewman is in full pressure suit and is operating external to the spacecraft (i.e., in free space). Life support may be provided either by umbilical connection or through utilization of an independent, portable Extravehicular Life Support System. Further, the EVA crewman may be either tethered or untethered depending on the particular function he is performing.
03.	<u>IVA</u> (Intravehicular Activity)	This environment is essentially the same as the EVA environment except that the crewman remains within the structural envelope of the spacecraft. The environment will be unpressurized, full pressure suits are required, and either umbilical or portable life support systems must be utilized.
04.	<u>POSITIVE GRAVITY</u>	An environmental condition in which gravitational or other external forces are acting on the experiment module or scientific crew member in a "downward" or footward direction. The force is defined as something greater than 10^{-2} "G", and may range well upwards of one "G". The G-forces may be a result of vehicle maneuvering, terrestrial gravitational pull, or an experimental procedure (e.g., a centrifuge).
05.	<u>NEGATIVE GRAVITY</u>	An environmental condition in which gravitational or other external forces are acting on the experiment module or scientific crew member in an "upward" or headward direction; the opposite of POSITIVE GRAVITY. The G-forces may be the result of vehicle maneuvering, terrestrial gravitational pull, or an experimental procedure (e.g., a centrifuge).
06.	<u>ROTO-GRAVITY</u>	An environmental condition wherein G forces are acting on the body through rotation or spinning of the body. The axis of rotation passes through some part of the body, or, because of body orientation to the axis, the forces act differentially on various parts of the body. ROTO-G may include both POSITIVE and NEGATIVE G forces.
07.	<u>TOXIC ATMOSPHERE</u>	An environmental condition in which the atmosphere upon which the crewman depends contains, or has a high potential for including, elements or materials which are capable of causing serious injury or illness. Such elements may be either gaseous or particulate and of chemical or biological origin.
08.	<u>SPECIAL GARMENT</u>	A condition in which the environment immediately adjacent to the body is altered by the wearing of some special types of clothing or protective gear beyond that which qualifies as "shirtsleeve". The EVA and IVA environments are specifically excluded from this category.

and the last three digits providing a profile of characteristic worker traits, interrelationships, and job complexities. A diagrammatic summary of the classification method is presented in Figure 2-8. It is estimated that the occupational group definitions in the Dictionary will encompass greater than 90% of the required on-orbit research and applications skills, and the method will be applicable to all skill requirements. Figure 2-9 illustrates the application of the classification method in determining the appropriate occupational skill category for a particular task-skill.

The actual process of the Occupational Title Search is not as complex as it may appear in Figure 2-9, because only the listings which do fit will be documented. This example has also documented the titles which would normally be discarded as not applicable.

2.2.7 Skill Groupings

Using the methods described in the preceding paragraphs, it is to be expected that an occupational skill will be common to many task-skills. This will provide for the first level of combining, which will be necessary in determining crew skill complements for planned missions. Further combinations are possible through groupings of all occupational titles which have the same 6-digit code number within areas of work. This kind of grouping is illustrated in Figure 2-10 for occupational code #003.081, the code number for the Radar Engineer in the preceding example. Each of the titles in this grouping are interrelated by the basic nature of the work and by the applicable worker traits profile. Suitable specialized training may also be required to satisfactorily fill the needs of the composite task-skills, however. Further combinations are possible, of course, but the interrelationship weakens with each level of combination, leading to greater requirements for specialized training. When such further combinations are needed, however, they are accomplished by grouping all titles which have the first three digits (e.g., 003.xxx) in common, with variations in the last three digits. Still more combinations may be made by comparing the job traits, etc., but recognizing that more extensive specialized training will be required.

A more complete description of the application of occupational skill classification and grouping to the Task-Skill Requirements Analysis is included in Reference 68.

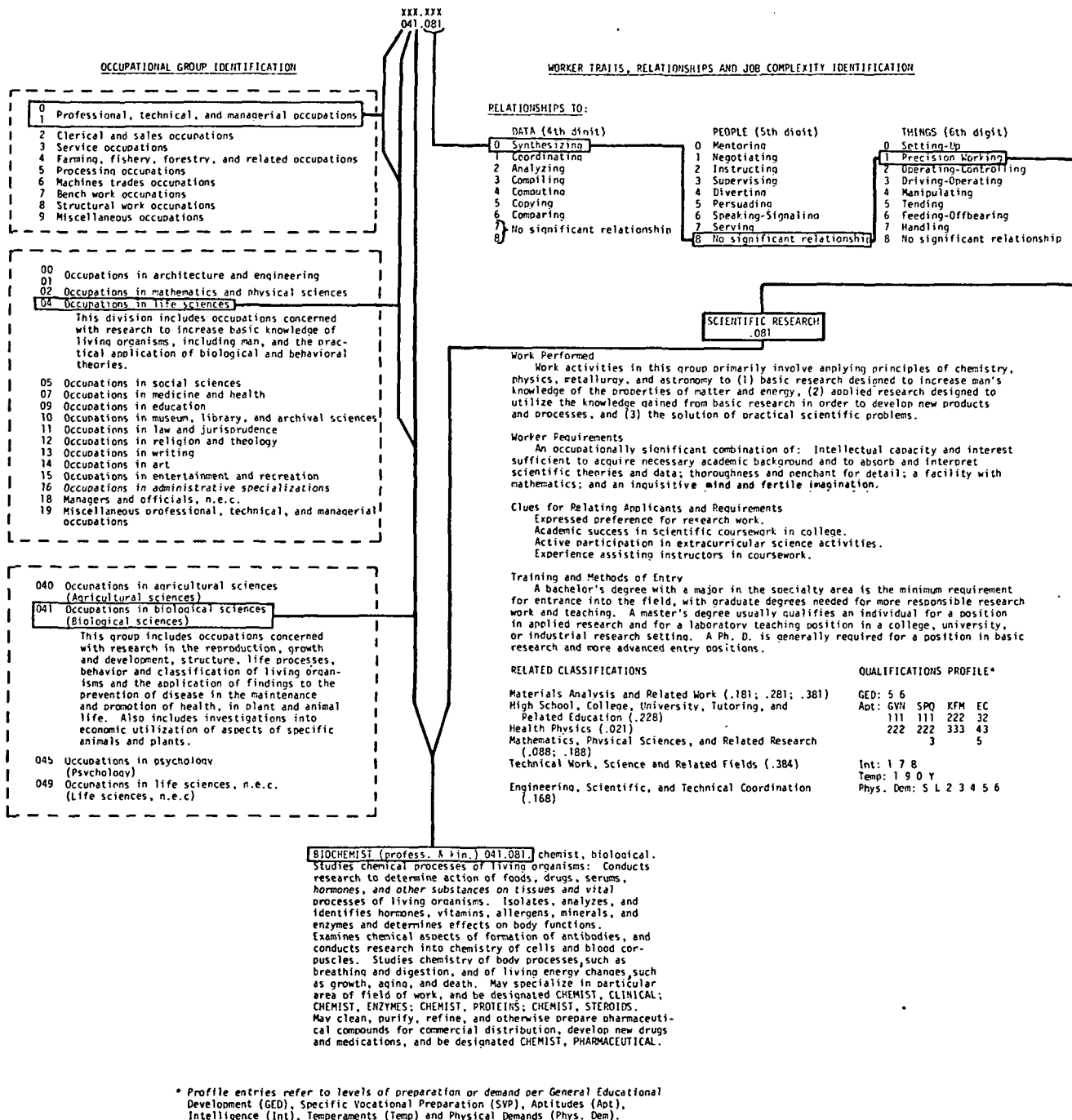


Figure 2-8: Example of Approach to Occupational Group Classification (Biochemist)

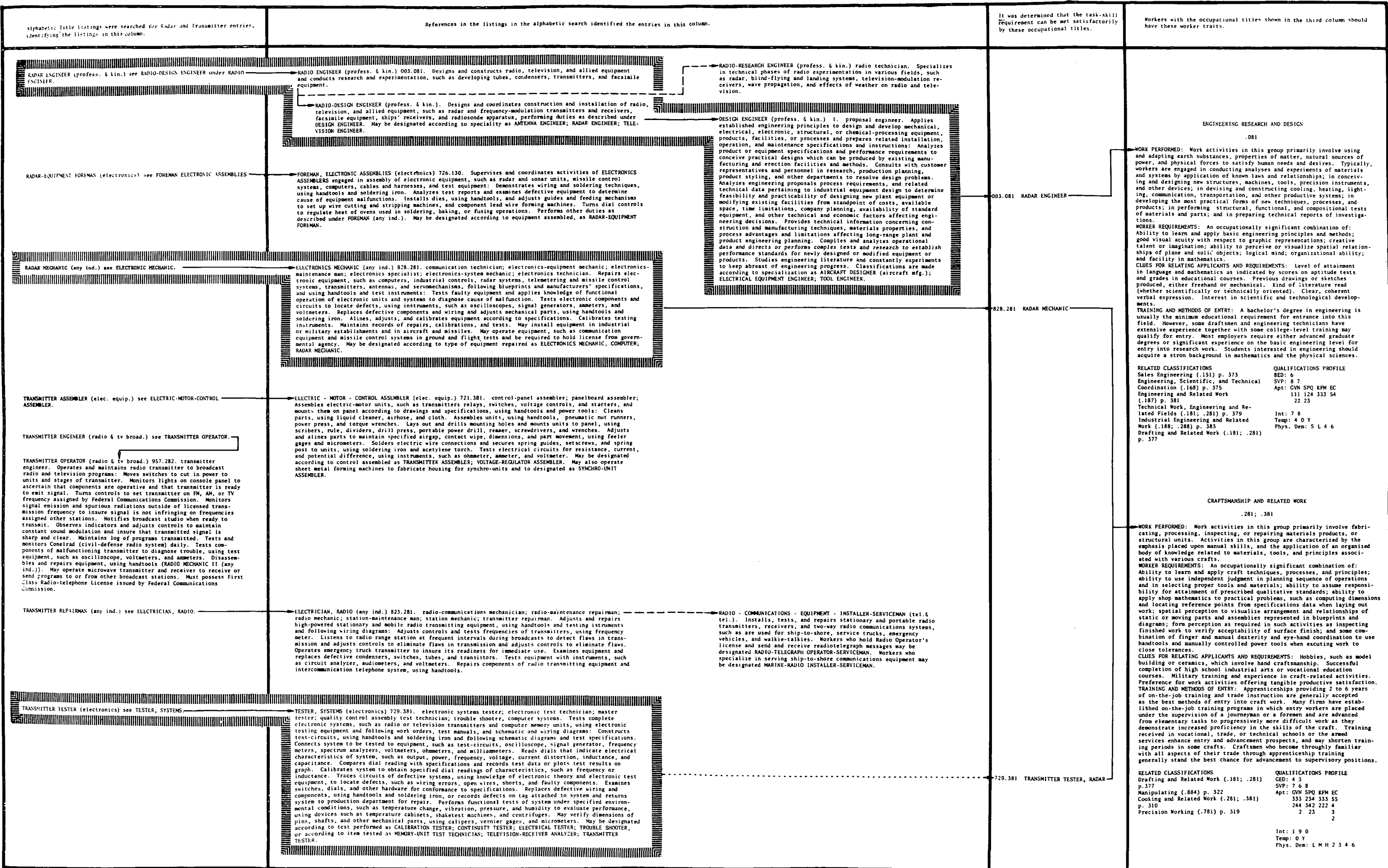


Figure 2-9: Occupational Skill Classification: Occupational Title Search. (Search for Radar Transmitter Operation Monitor. Task Skill No. 0812)

ENGINEERING RESEARCH & DESIGN[@]

- | | | |
|----------|---|--|
| 00
01 | } | <u>ARCHITECTURE AND ENGINEERING</u> |
| | | |
| 003. | | <u>Electrical Engineering</u> |
| 003.081 | | ELECTRICAL ENGINEER (profess. & kin.)
ELECTRICAL-EQUIPMENT ENGINEER (profess. & kin.)
ELECTRICAL-PROSPECTING ENGINEER (petrol. production)
SIGNAL ENGINEER (profess. & kin.)
ELECTRICAL-RESEARCH ENGINEER (profess. & kin.)
ELECTRONIC ENGINEER (profess. & kin.)
AUDIO ENGINEER (profess. & kin.)
ELECTRONIC-ORGAN ENGINEER (profess. & kin.)
ILLUMINATING ENGINEER (profess. & kin.)
BUILDING-ILLUMINATING ENGINEER (profess. & kin.)
ILLUMINATING-RESEARCH ENGINEER (profess. & kin.)
INDUSTRIAL-ILLUMINATING ENGINEER (profess. & kin.)
OUTDOOR-ILLUMINATING ENGINEER (profess. & kin.)
POWER-PLANT ENGINEER (light, heat, & power)
RADIO ENGINEER (profess. & kin.)
RADIO-DESIGN ENGINEER (profess. & kin.)
RADIO-RESEARCH ENGINEER (profess. & kin.)
ROCKET-ENGINE-TEST ENGINEER (aircraft mfg.)
TELEGRAPH ENGINEER (tel. & tel.)
TELEPHONE ENGINEER (tel. & tel.)
EQUIPMENT ENGINEER (tel. & tel.)
LINE-CONSTRUCTION ENGINEER (tel. & tel.)
TELECOMMUNICATIONS-SERVICE ENGINEER (tel. & tel.) |

[@]Notes area of work

Figure 2-10: Occupational Title Grouping Within Areas of Work

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

SECTION 3.0

RESULTS OF SKILLS ANALYSIS



SECTION 3.0

RESULTS OF SKILLS ANALYSIS

3.1 GENERAL

This section of the report presents the results of efforts under this contract to determine the applicable task skills, primary occupational skills, and mission occupational skills for two classes of orbital research utilizing the projected Sortie Lab. The disciplines -- and Sortie Lab payloads -- included are shown in Table 3-1. Rationale for exclusion of some specific payloads or experiments from these two disciplines is also given.

The approach which led to selection of these particular groups of experiments, as well as the methodology utilized in identifying the needed skills, is explained in Section 2.0 of the report. Within these two research disciplines, deletion of certain payloads was based on considerations such as their not being likely missions for the 1979 - 1982 time frame, or their unlikely selection as Sortie Lab missions. These two types of research present a significant contrast, in terms not only of the nature and objectives of the experimentation but also in terms of the types of equipment involved and the system constraints while research is in progress. The Earth Observations group, of course, utilizes the orbiting laboratory as a vantage point, sufficiently distant from the earth's surface that large areas may be observed, yet not so distant that the observing instruments and sensors cannot collect detailed data when appropriate. The nominal weightless environment is an imposition on the experiment crew as a fact of being in orbit, rather than a constraint on the system dictated by the experiment requirements. Minor changes in G-level will, in fact, occur almost continuously as the orbiting vehicle strives to maintain Z-local vertical during a data pass. In addition, the Sortie Lab Earth Observations facility is a combination of a relatively small pressurized module for housing the operating crew, and an external pallet on which the observation instruments will be mounted.

The Materials Sciences experiments, on the other hand, have no requirement for earth viewing, and distance from the earth's surface is determined by orbital dynamics. A nearly perfect zero-G condition is a constraint imposed on the system by the requirements of the experiments. During some of the more critical phases of some experiments, even movements about the orbital laboratory by the experiment crew could conceivably cause disturbances in the materials being processed, affecting the resultant data. (This factor, not incidentally, increases the desirability of a centralized control/display console for Materials Sciences experiments; see Section 4.0). The Materials Sciences facility is planned as a totally pressurized module, requiring no external pallet.

TABLE 3-1: Screening of Payloads and Experiments in Earth Observations and Materials Sciences

DISCIPLINE	Sortie Lab Program (Ref. #157) Payload Experiment	NAS8-28359 Skills Analysis			Reason for Exclusion*
		Included	Excluded		
Earth Observations	EO-1 Meteorology and the Atmospheric Sciences		x	Not scheduled for "early" mission.	
	EO-2 World Land Use Mapping		x	Not scheduled for "early" mission; little crew activity.	
	EO-3 Air and Water Pollution	x			
	EO-4 Resource Recognition and Identification	x			
	EO-5 Natural Disaster Assessment and Anomalies	x			
	EO-6 Ocean Resources		x	Not scheduled for "early" mission. At time of study baseline, experiment descriptions were inadequate. Not believed to be scheduled for an early mission.	
	EO-7 Atmospheric Cloud Physics		x		
	EO-8 Freezing Drop Experiment		x		
	EO-9 Droplet Charging Experiment		x		
Materials Sciences and Manufacturing	MS-1 Biological Experiments	x		Not scheduled for "early" mission.	
	(1) Separation of Biologicals				
	(2) Preservation of Biologicals				
	MS-2 Levitation Experiments				
	(1) Preparation of Glasses	x			
	(2) Supercooling	x			
	(3) Some Crystals	x			
	MS-3 Furnace Experiments				
	(1) Composite Materials	x			
	(2) Directional Solidification	x			
	MS-4 Small and Low Temperature Experiments				
	(1) Physics of Fluids	x			
(2) Zone Refining	x				

*Early Shuttle missions were arbitrarily defined as those being planned for the first four years of Shuttle operation, i.e., 1979 - 1982.

Thus, while the selection of these two research areas is certainly not all-inclusive of projected Sortie-Lab payloads and experiments, it does cut across a broad range of types of activities and conditions of research. The specific skill-related data for the Earth Observations payloads is presented in Section 3.2; that for Materials Sciences payloads is presented in Section 3.3.

3.2 EARTH OBSERVATIONS PAYLOADS

Three Earth Observations experiment areas, designated for flight as Sortie Lab payloads, were analyzed in detail:

- EO-3 Air and Water Pollution
- EO-4 Resource Recognition
- EO-5 Disaster Assessment

3.2.1 Task Statement Screening

The Crew Function Worksheets, an example of which is illustrated in Figure 2-6, were first screened to eliminate duplication of task statements and to delete any task statements which were clearly contrary to published guidelines (Refs. 46, 48, 49, 92, 112, 114, 116, 119) for early Sortie Lab missions. Examples of the former are "Set up observation equipment" versus "Set up experiment equipment". The broader task statement was generally selected, since it encompassed a greater variety of payload equipment. Deletion of duplicative and partially duplicative task statements avoided incurring artificially high frequencies of identical crew functions, task dependencies, and task-skills. Although actual frequency counts were not made (since task repetition, which would certainly affect frequencies, could not be factored in), subjective judgments of frequencies, especially for task-skills, did influence choices in the grouping of primary occupational skills into mission occupational skills. Task statements which were deleted, based on guidelines, tended to be those which were oriented toward longer duration missions or which were dependent on types of support equipment being present which were not likely to be orbited on the more austere early missions. In the long-duration mission category were all "scheduled maintenance" tasks (Basic Function 09), since it was unlikely that any equipment would be orbited which would require scheduled maintenance during a 7-day mission. This, of course, does not include requirements for cleaning, decontamination of equipment, etc., which would normally be part of the experiment shutdown procedures (Basic Function 05), when appropriate. Task statements in the "unscheduled maintenance" area (Basic Function 10) were originally planned for deletion as well, but those tasks relating to "repair" activities were partially reinstated based on the experiences of the Skylab 1/2 Mission. Even with only marginally adequate tools, in combination with knowledgeable crewmen, a mission which might otherwise be aborted or seriously degraded because of failure of some critical item of equipment can still be successful.

At a more specific level, tasks which would require provision of supporting subsystems not expected to be included on early Sortie Lab missions were partially screened. Thus, tasks relating to operation of a photographic enlarger were eliminated. Tasks requiring development of film were left in,

since this may be a requirement as mission durations are gradually lengthened, but the Primary Occupational Skills which resulted were excluded from the groupings for determining Mission Occupational Skills.

3.2.2 Task/Skill Requirements Analysis

The remaining Task Statements were entered onto Task/Skill Requirements analysis sheets, an example of which is shown in Figure 3-1. The complete set of analysis sheets for the Earth Observations experiments analyzed is included in Appendix H of this report. Crew function codes and operating environment codes were taken directly from the Crew Function Worksheets. Primary and secondary task dependencies were identified according to the methodology previously described (see Section 2.2), and an appropriate Task-Skill title was entered, characterizing the function and the interface or activity which was to be performed. Subsequently, the Task-Skill titles were related (one-for-one) to Primary Occupational Skill titles.

FLIGHT EXPERIMENT TASK /SKILL REQUIREMENTS

DISCIPLINE: EARTH RESOURCES				FPE: ES-1 Earth Observation				MISSION MODE: A - Shuttle Sortie			
EXPERIMENT AREA: Sortie Lab Payload EO-4				EXPERIMENT: 4.0 - Resource Location and Identification				BASIC FUNCTION: 06 - Experiment Conduct			
CREW TASK STATEMENT		CREW FUNCT. NO.	OPER. ENVIR. NO.	TASK DEPENDENCY NO.		TASK - SKILL		PRIMARY OCCUPATIONAL SKILL		REFERENCE NOTE NO.	
NO.	DESCRIPTION			PRIMARY	SECONDARY	TITLE	NO.	NO.	TITLE		
17	(Continued)	01	01	2.B.04-18	2.F.01 2.F.03 4.B.01-2	Telescope Operation Monitor	2099	003.281	Instrumentation Technician		
19	Review data collected for quality and usefulness	11	01	3.C.07	2.F.03-2 2.F.03-3 2.A.27-4 2.A.10-1 2.A.21-2 2.A.23 2.A.03-15 2.B.09 2.F.02-5 2.A.03-13 2.A.12-16 2.A.12-17	Land Use Data Evaluator	2108	024.081	Geophysicist		
20	Identify irrelevant data	04	01	3.C.07	2.F.02-5 2.F.03-2 2.F.03-3 2.A.27-4 2.A.19-1 2.A.23 2.A.03-15 2.B.09 2.A.03-13 2.A.12-15 2.A.12-17	Land Use Data Classifier	2115	024.081	Geophysicist		
21	Process film	06	01	4.B.08	2.A.27-1 2.A.27-2 2.A.27-3 2.A.27-4 2.A.27-5	Film Developer	0328	976.782	Film Developer	EO-2	
REVISION NO:		REVISION DATE:		PREPARED BY: JHL/GRH/EMW		APPROVED BY: GRH		SERIES ES-1-A		PAGE EO-4-06-12	

Figure 3-1: Example of Task/Skill Requirements Analysis Data Sheet, Earth Observations

3.2.3 Earth Observations Skill Requirements

3.2.3.1 Air and Water Pollution (EO-3)

The Air and Water Pollution experiment analysis resulted in the identification of 156 different task-skill titles, which were correlated to fourteen (14) different primary occupational skills. Payload EO-3 task-skills and their respective primary and mission occupational skills are included in the listing in Table 3-2. Determination of the appropriate mission occupational skill was made as described in Section 2.2. Actual groupings which took place are illustrated in Figure 3-2. As shown, the analysis leads to the conclusion that all of the experiment tasks for payload EO-3 can be accomplished by a crew complement with the following Occupational Skills:

- #003.281 Instrumentation Technician
- #024.081 Geophysicist
- #828.281 Electronics Mechanic

As noted in Figure 3-2, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. It should be understood that this does not necessarily represent a crew complement of three individuals, i.e., one with each of the listed MOSs. Until such time as detailed experiment timelines and workload analyses can be accomplished, such a conclusion would have no validity.

3.2.3.2 Resource Recognition (EO-4)

Analysis of the Resource Recognition experiment resulted in the identification of 144 different task-skill titles, which were correlated to thirteen (13) different Primary Occupational Skills. Payload EO-4 task-skills, and their respective primary and mission occupational skills are listed in Table 3-2. Selection of the appropriate MOS was made in accordance with the methodology discussed in Section 2.2. Groupings which resulted are the same as those for payload EO-3, as illustrated in Figure 3-2:

- #003.281 Instrumentation Technician
- #024.081 Geophysicist
- #828.281 Electronics Mechanic

Cross-training requirements will be essentially the same as for payload EO-3, although perhaps not quite as extensive. Also, as discussed in paragraph 3.2.3.1, this listing is for a complement of occupational skills and does not necessarily represent a crew of three individuals.

3.2.3.3 Disaster Assessment (EO-5)

Experiment task analysis for this payload resulted in the identification of 264 task-skills. Using the techniques described in Section 2.2, these were

TABLE 3-2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sorite Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).

TASK - SKILL		PAYLOADS/EXPERIMENTS @					OCCUPATIONAL SKILLS																
		EO-3	Air & Water Pollution	EO-4	Resources Recognition	EO-5	Disaster Assessment																
CODE	TITLE																						
0001	Telescope Inspector																						
0004	Telescope Optics Cleaner																						
0036	Spectrometer Control Actuator																						
0038	Spectrometer Fault Identifier																						
0040	Spectrometer Tester																						
0046	Film Cartridge Installer																						
0054	TV Camera Unstower																						
0072	Spectrometer Calibrator																						
0095	Spectrometer Optics Cleaner																						
0096	TV Camera Optics Cleaner																						
0097	Camera Lens (Optics) Cleaner																						
0109	Spectrometer Module Remover																						
0110	Spectrometer Module Installer																						
0111	TV Camera Module Remover																						
0112	TV Camera Module Installer																						
0158	Camera Module Remover																						
0160	Camera Module Installer																						
0187	Telescope Module Remover																						
0188	Telescope Module Installer																						
0204	Camera Mode Monitor																						
0206	Radio Communicator																						
0209	Scanner Mode Monitor																						
0212	TV Camera Mode Monitor																						
0245	Camera Control Actuator																						
0265	Telescope Mode Selector																						
0267	Spectrometer Mode Selector																						
0268	TV Mode Selector																						
0271	Camera Mode Selector																						
0292	Camera Unstower																						
0294	Camera Inspector																						
0297	Telescope Aligner																						
0303	Telescope Unstower																						
0320	Telescope Control Deactuator																						
0328	Film Processor *																						
0335	Camera Controller **																						
0336	Spectrometer Controller **																						
0337	Telescope Controller **																						
0345	TV System Module Remover																						
0346	TV System Module Installer																						
0409	Spectrometer Control Deactuator																						
0516	Meteorological Condition Observer																						
0519	Computer Module Remover																						
0520	Computer Module Installer																						
0611	Radar Transmitter Unstower																						
0613	Radar Transmitter Tester																						
0615	Radar Transmitter Module Remover																						
0616	Radar Transmitter Module Installer																						
0623	Radar Receiver Module Installer																						
0624	Radar Receiver Module Remover																						
0627	Radar Receiver Tester																						
0628	Radar Transmitter Unstower																						
0637	Radiometer Module Installer																						
0638	Radiometer Module Remover																	</					

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

*No Occupational Skill Assigned; see text, paragraph 3.2.1

**No Mission Occupational Skill Assigned; see text and Figure 3-2

@ The skill listings for each experiment, individually, are included in Appendix C

**TABLE 3-2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)**

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS											
CODE	TITLE	EO-3	EO-4	EO-5		CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Meteorologist	Weather Observer	Calibrator
0644	Radiometer Mode Monitor	△	△	△		000.000											
0653	Polarimeter Mode Monitor	△	△	△		003.181											
0664	Radar Transmitter Control Deactuator	△	△	△		003.187											
0666	Radar Receiver Control Deactuator	△	△	△		003.187											
0672	TV Camera Control Deactuator	△	△	△		003.281											
0673	Radiometer Control Deactuator	△	△	△		007.081											
0683	Radar Transmitter Fault Identifier	△	△	△		018.188											
0684	Radar Transmitter Repairer	△	△	△		024.081											
0685	Radar Receiver Fault Identifier	△	△	△		024.081											
0686	Radar Receiver Repairer	△	△	△		025.088											
0689	TV Camera Fault Identifier	△	△	△		025.288											
0691	Radiometer Fault Identifier	△	△	△		710.884											
0692	Radiometer Repairer	△	△	△		714.684											
0779	Spectrometer Repairer	△	△	△		722.281											
0787	Spectrometer Mode Monitor	△	△	△		828.281											
0795	Electronic Equipment Fault Identifier	△	△	△		xxx.xxx											
0812	Radar Transmitter Operation Monitor	△	△	△													
0823	Scanner Unstower	△	△	△													
0825	Sferics Detector Unstower	△	△	△													
0828	Scanner Inspector	△	△	△													
0829	Radiometer Inspector	△	△	△													
0831	Polarimeter Inspector	△	△	△													
0832	Sferics Detector Inspector	△	△	△													
0833	Spectrometer Inspector	△	△	△													
0837	Radiometer Calibrator	△	△	△													
0842	Scanner Control Actuator	△	△	△													
0843	Radiometer Control Actuator	△	△	△													
0844	Polarimeter Control Actuator	△	△	△													
0845	Sferics Detector Control Actuator	△	△	△													
0846	Telescope Control Actuator	△	△	△													
0848	Camera Control Deactuator	△	△	△													
0849	Scanner Control Deactuator	△	△	△													
0852	Film Stower	△	△	△													
0853	Sferics Detector Control Deactuator	△	△	△													
0869	Scanner Data Quality Monitor	△	△	△													
0870	Radiometer Data Quality Monitor	△	△	△													
0872	Spectrometer Data Quality Monitor	△	△	△													
0873	Polarimeter Data Quality Monitor	△	△	△													
0874	Telescope Operation Evaluator	△	△	△													
0875	Camera Operation Evaluator	△	△	△													
0876	Scanner Operation Evaluator	△	△	△													
0877	Radiometer Operation Evaluator	△	△	△													
0879	Spectrometer Operation Evaluator	△	△	△													
0880	Polarimeter Operation Evaluator	△	△	△													
0882	Sferics Detector Data Quality Monitor	△	△	△													
0884	Scanner Optics Cleaner	△	△	△													
0885	Telescope Fault Identifier	△	△	△													
0886	Camera Fault Identifier	△	△	△													
0887	Scanner Fault Identifier	△	△	△													
0889	Polarimeter Fault Identifier	△	△	△													
0890	Sferics Detector Fault Identifier	△	△	△													
0891	Optical Equipment Fault Identifier	△	△	△													
0895	Telescope Presentation Observer	△	△	△													
0896	TV Presentation Observer	△	△	△													
0897	Scanner Presentation Observer	△	△	△													

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

**TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)**

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS											
		EO-3	EO-4	EO-5			CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer
CODE	TITLE							000.000	003.181	003.187	003.187	003.281	007.081	018.188	024.081	024.081	025.088	025.288
0898	Radiometer Presentation Observer																	
0899	TV Camera Control Actuator																	
0904	Scanner Module Remover																	
0905	Scanner Module Installer																	
0908	Polarimeter Module Remover																	
0909	Polarimeter Module Installer																	
0914	Polarimeter Presentation Observer																	
0915	Spectrometer Presentation Observer																	
0916	Scanner Mode Selector																	
0917	Radiometer Mode Selector																	
0918	Polarimeter Mode Selector																	
0919	Polarimeter Control Deactuator																	
0921	Telescope Pointing Controller **																	
0922	TV Data Quality Monitor																	
0923	TV Camera Operation Evaluator																	
0924	Radiometer Optics Cleaner																	
0925	Polarimeter Optics Cleaner																	
0926	Earth Survey C/D Equipment Module Remover																	
0927	Earth Survey C/D Equipment Module Installer																	
0928	Earth Survey C/D Equipment Fault Identifier																	
0932	Radar Transmitter Inspector																	
0933	Radar Receiver Inspector																	
0934	Radar Presentation Observer																	
0935	Radar Transmitter Control Actuator																	
0936	Radar Receiver Control Actuator																	
0937	Sferics Detector Presentation Observer																	
0938	Radar Transmitter Mode Selector																	
0939	Radar Receiver Mode Selector																	
0940	Sferics Detector Mode Selector																	
0941	Forest Fire Disaster Identifier																	
0942	Telescope Mode Monitor																	
0943	Telescope Mode Recorder																	
0944	Radar Data Quality Monitor																	
0945	Sferics Detector Optics Cleaner																	
0946	Sferics Detector Module Remover																	
0947	Sferics Detector Module Installer																	
1193	Telescope Repairer																	
1194	TV System Repairer																	
1195	Camera Repairer																	
1344	Camera Operation Monitor																	
1448	Camera Tester																	
1549	TV System Control Actuator																	
2045	TV Camera Mode Recorder																	
2046	Scanner Mode Recorder																	
2047	Radiometer Mode Recorder																	
2048	Polarimeter Mode Recorder																	
2049	Spectrometer Mode Recorder																	
2050	Camera Status Monitor																	
2051	Time Elapsed Observer **																	
2052	TV Camera Status Monitor																	
2053	Atmospheric Pollution Data Observer																	
2054	Water Pollution Data Observer																	
2055	Water Pollution Data Evaluator																	
2056	Atmospheric Pollution Data Evaluator																	
2057	Meteorological Conditions Evaluator																	

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS			OCCUPATIONAL SKILLS																
CODE	TITLE	EO-3 Air & Water Pollution	EO-4 Resources Recognition	EO-5 Disaster Assessment	CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill
2058	Mission Events Evaluator **	△	△	△																	
2059	TV System Inspector	△	△	△																	
2060	TV System Tester	△	△	△																	
2061	Scanner Tester	△	△	△																	
2062	Polarimeter Tester	△	△	△																	
2063	Polarimeter Aligner	△	△	△																	
2064	TV System Fault Identifier	△	△	△																	
2065	Earth Survey C/D Equipment Repairer	△	△	△																	
2066	Scanner Repairer	△	△	△																	
2067	Polarimeter Repairer	△	△	△																	
2068	TV System Control Deactuator	△	△	△																	
2076	TV Data Classifier	△	△	△																	
2077	Scanner Data Classifier	△	△	△																	
2078	Radiometer Data Classifier	△	△	△																	
2079	Polarimeter Data Classifier	△	△	△																	
2080	Spectrometer Data Classifier	△	△	△																	
2081	Polarimeter Controller **	△	△	△																	
2082	TV Data Analyzer	△	△	△																	
2083	Scanner Data Analyzer	△	△	△																	
2084	Radiometer Data Analyzer	△	△	△																	
2085	Polarimeter Data Analyzer	△	△	△																	
2086	Spectrometer Data Analyzer	△	△	△																	
2087	Telescope Data Analyzer	△	△	△																	
2088	Scanner Adequacy Determiner	△	△	△																	
2089	TV Camera Adequacy Determiner	△	△	△																	
2090	Radiometer Adequacy Determiner	△	△	△																	
2091	Polarimeter Adequacy Determiner	△	△	△																	
2092	Telescope Adequacy Determiner	△	△	△																	
2093	Camera Adequacy Determiner	△	△	△																	
2094	TV System Operation Monitor	△	△	△																	
2095	Scanner Operation Monitor	△	△	△																	
2096	Radiometer Operation Monitor	△	△	△																	
2097	Polarimeter Operation Monitor	△	△	△																	
2098	Spectrometer Operation Monitor	△	△	△																	
2099	Telescope Operation Monitor	△	△	△																	
2100	Atmospheric Pollution Data Classifier	△	△	△																	
2101	Water Pollution Data Classifier	△	△	△																	
2102	Video Data Quality Evaluator	△	△	△																	
2103	Radar Transmitter Mode Monitor	△	△	△																	
2104	Radar Receiver Mode Monitor	△	△	△																	
2105	Radar Transmitter Mode Recorder	△	△	△																	
2106	Radar Receiver Mode Recorder	△	△	△																	
2107	Land Use Data Observer	△	△	△																	
2108	Land Use Data Evaluator	△	△	△																	
2109	Radar Data Classifier	△	△	△																	
2110	Telescope Data Classifier	△	△	△																	
2111	Spectrometer Adequacy Determiner	△	△	△																	
2112	Radar Transmitter Adequacy Determiner	△	△	△																	
2113	Radar Receiver Adequacy Determiner	△	△	△																	
2114	Radar Operation Monitor	△	△	△																	
2115	Land Use Data Classifier	△	△	△																	
2116	Earth Surface Landmark Observer	△	△	△																	
2117	Earth Surface Landmark Classifier	△	△	△																	
2118	Sferics Detector Mode Monitor	△	△	△																	
2119	Sferics Detector Mode Recorder	△	△	△																	

△ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

△ = Primary Occupational Skill. X = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

**No Mission Occupational Skill Assigned; see text and Figure 3-2

Table 3-2, p. 4 of 7

TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortle Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS											
		EO-3	EO-4	EO-5		CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer
CODE	TITLE						000.000	003.181	003.187	003.187	003.281	007.081	018.188	024.081	024.081	025.088	025.288
2120	Camera Mode Recorder																
2121	Geological Precursor Data Observer																
2122	Geological Precursor Data Evaluator																
2123	Earthquake Data Observer																
2124	Earthquake Data Evaluator																
2125	Sferics Detector Tester																
2126	Telescope Tester																
2127	Sferics Detector Adequacy Determiner																
2128	Meteorological Precursor Data Observer																
2129	Artificial Precursor Data Observer																
2130	Topographical Precursor Data Observer																
2131	Precursor Disaster Data Observer																
2132	Meteorological Precursor Data Evaluator																
2133	Artificial Precursor Data Evaluator																
2134	Topographical Precursor Data Evaluator																
2135	Precursor Disaster Data Evaluator																
2136	Hurricane Data Observer																
2137	Tornado Data Observer																
2138	Tidal Wave Data Observer																
2139	Flood Data Observer																
2140	Volcanic Eruption Data Observer																
2141	Forest Fire Data Observer																
2142	Range Fire Data Observer																
2143	Landslide Data Observer																
2144	Snowslide Data Observer																
2145	Land Subsidence Data Observer																
2146	Drought Data Observer																
2147	Blizzard Data Observer																
2148	Hurricane Data Evaluator																
2149	Tornado Data Evaluator																
2150	Tidal Wave Data Evaluator																
2151	Flood Data Evaluator																
2152	Volcanic Eruption Data Evaluator																
2153	Forest Fire Data Evaluator																
2154	Range Fire Data Evaluator																
2155	Landslide Data Evaluator																
2156	Snowslide Data Evaluator																
2157	Land Subsidence Data Evaluator																
2158	Drought Data Evaluator																
2159	Blizzard Data Evaluator																
2160	Geological Precursor Observer																
2161	Meteorological Precursor Observer																
2162	Artificial Precursor Observer																
2163	Topographical Precursor Observer																
2164	Precursor Disaster Observer																
2165	Geological Precursor Classifier																
2166	Meteorological Precursor Classifier																
2167	Artificial Precursor Classifier																
2168	Topographical Precursor Classifier																
2169	Precursor Disaster Classifier																
2170	Sferics Detector Data Classifier																
2171	Earthquake Disaster Predictor																
2172	Hurricane Disaster Predictor																
2173	Tornado Disaster Predictor																
2174	Tidal Wave Disaster Predictor																

○ = Primary Occupational Skill. ✕ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

**TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)**

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS											
		EO-3	EO-4	EO-5			CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer
CODE	TITLE							000.000	003.181	003.187	003.187	003.281	007.081	018.188	024.081	024.081	025.088	025.288
2175	Flood Disaster Predictor																	
2176	Volcanic Eruption Disaster Predictor																	
2177	Forest Fire Disaster Predictor																	
2178	Range Fire Disaster Predictor																	
2179	Landslide Disaster Predictor																	
2180	Snowslide Disaster Predictor																	
2181	Land Subsidence Disaster Predictor																	
2182	Drought Disaster Predictor																	
2183	Blizzard Disaster Predictor																	
2184	TV Camera Mode Selector																	
2185	Radar Receiver Operation Monitor																	
2186	Sferics Detector Operation Monitor																	
2187	Recorder Control Actuator																	
2188	Geological Precursor Data Classifier																	
2189	Meteorological Precursor Data Classifier																	
2190	Artificial Precursor Data Classifier																	
2191	Topographical Precursor Data Classifier																	
2192	Precursor Disaster Data Classifier																	
2193	Earthquake Data Classifier																	
2194	Hurricane Data Classifier																	
2195	Tornado Data Classifier																	
2196	Tidal Wave Data Classifier																	
2197	Flood Data Classifier																	
2198	Volcanic Eruption Data Classifier																	
2199	Forest Fire Data Classifier																	
2200	Range Fire Data Classifier																	
2201	Landslide Data Classifier																	
2202	Snowslide Data Classifier																	
2203	Land Subsidence Data Classifier																	
2204	Drought Data Classifier																	
2205	Blizzard Data Classifier																	
2206	Geological Precursor Communicator																	
2207	Meteorological Precursor Communicator																	
2208	Artificial Precursor Communicator																	
2209	Topographical Precursor Communicator																	
2210	Precursor Disaster Communicator																	
2211	Earthquake Disaster Communicator																	
2212	Hurricane Disaster Communicator																	
2213	Tornado Disaster Communicator																	
2214	Tidal Wave Disaster Communicator																	
2215	Flood Disaster Communicator																	
2216	Volcanic Eruption Disaster Communicator																	
2217	Forest Fire Disaster Communicator																	
2218	Range Fire Disaster Communicator																	
2219	Landslide Disaster Communicator																	
2220	Snowslide Disaster Communicator																	
2221	Land Subsidence Disaster Communicator																	
2222	Drought Disaster Communicator																	
2223	Blizzard Disaster Communicator																	
2224	Earthquake Disaster Identifier																	
2225	Hurricane Disaster Identifier																	
2226	Tornado Disaster Identifier																	
2227	Tidal Wave Disaster Identifier																	
2228	Flood Disaster Identifier																	
2229	Volcanic Eruption Disaster Identifier																	

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

**TABLE 3.2: Correlation of Task-Skills with Payloads and Occupational Skills,
Sortie Lab Multi-Experiment Earth Observations Payload (EO-3, EO-4, EO-5).
(Continued)**

TASK - SKILL		PAYLOADS / EXPERIMENTS						OCCUPATIONAL SKILLS																
CODE	TITLE	EO-3 Air & Water Pollution	EO-4 Resources Recognition	EO-5 Disaster Assessment				CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill
2230	Range Fire Disaster Identifier							000.000																
2231	Landslide Disaster Identifier							003.181																
2232	Snowslide Disaster Identifier							003.187																
2233	Land Subsidence Disaster Identifier							003.187																
2234	Drought Disaster Identifier							003.281																
2235	Blizzard Disaster Identifier							007.081																
2236	Telescope Data Quality Monitor							018.188																
2237	Sferics Detector Repairer							024.081																
	All Earth Observations Payloads							025.088																
								710.884																
								714.684																
								722.281																
								828.281																
								xxx.xxx																

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

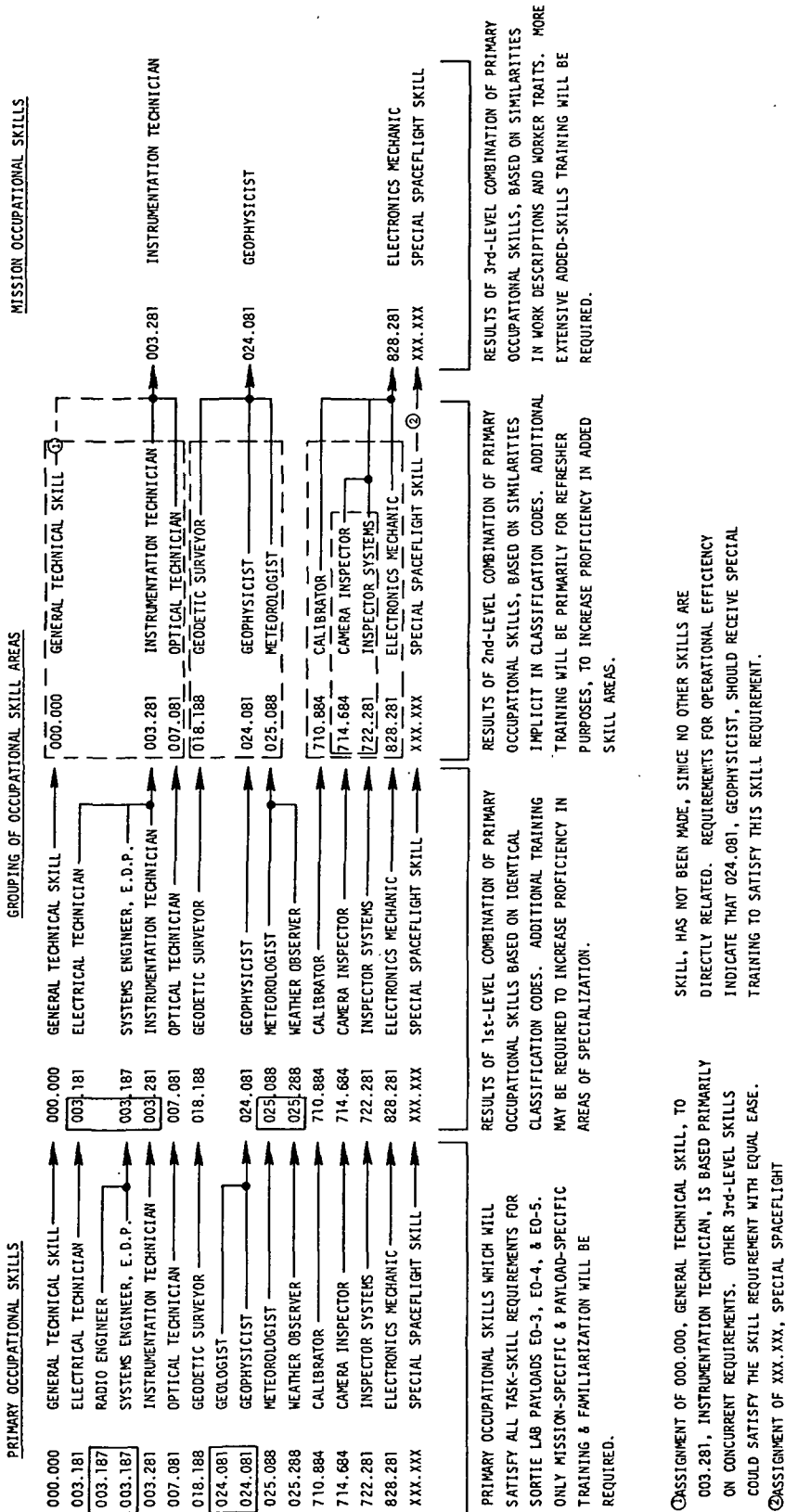


Figure 3-2: Derivation of Mission Occupational Skills for Sortie Lab Earth Observations Payloads EO-3, EO-4, and EO-5

correlated to fifteen (15) different primary occupational skills. Table 3-2 shows the relationship of payload EO-5 task-skills, primary occupational skills, and mission occupational skills. Groupings which resulted are the same as those for payloads EO-3 and EO-4, as illustrated in Figure 3-2. These are:

#003.281 Instrumentation Technician
#024.081 Geophysicist
#828.281 Electronics Mechanic

Cross-training requirements for the technical skills (i.e., 003.281; 828.281) will be essentially the same as for payloads EO-3 and EO-4. Skill broadening requirements will, however, probably be much more extensive for the Geophysicist (024.081) due to the wide range of knowledge required for interpreting incipient disaster observations of all types. Conversely, since payload EO-5 is unlikely to ever be orbited independently of other experiment payloads (because of nonpredictability of disaster occurrence), the extent of such skill-expansion training for purposes of disaster assessment alone will probably be minimal. However, since the Geophysicist skill is a choice common to all three EO payloads, training should be sufficiently extensive to prepare the individual assigned this role for effective response when disasters (potential or actual) are observed.

As for the previous payloads, the listed Mission Occupational Skills should not be construed as representing three individual crew members.

3.2.3.4 Multiexperiment Earth Observations Payloads

Although the task and skills analyses for the encompassed Earth Observations experiments were accomplished at the designated payload level, it is quite likely that a specific Earth Observations mission will include more than one of the separate payloads. Thus, EO-3 and EO-4 may be orbited together, as might be any other combination of the three payloads (EO-3, EO-4, EO-5). It is also possible that one or more EO payloads may be joined by one or more compatible payloads from other EO research areas or from other disciplines (e.g., Astronomy, Physics, etc.). Assuming the joint flight of payloads EO-3, EO-4, and EO-5, the commonality of task-skills across the three experiments was determined, as illustrated in Table 3-2. As can be seen, task-skill commonality is quite high when the primary task dependency is an equipment interface. Commonality is lower in those task-skills where a specific area of knowledge is the determinant, but still occurs frequently.

Still more significant is that even though the number of required task-skills for the three combined payloads increases to 343, the number of Primary Occupational Skills is only increased to sixteen (16), all of which are grouped into the same three Mission Occupational Skills:

#003.281 Instrumentation Technician
#024.081 Geophysicist
#828.281 Electronics Mechanic

Cross-training requirements obviously will be greatly increased in order to accommodate all task-skill requirements. However, as is illustrated in Table 3-3, there is little additional impact on skill requirements when a payload with two experiments is increased to accommodate all three experiments. This is especially true if, as is likely, one of the two initial experiments is Disaster Assessment (EO-5).

Table 3-3: Comparison of Single Experiment Payloads to Multiple Experiment Payloads, Earth Observations

Payloads			Number of Task Skills	Number of Primary Occupational Skills ①	Number of Mission Occupational Skills ②
EO-3	EO-4	EO-5			
X			156	14	3
	X		144	13	3
		X	264	15	3
X	X		192	14	3
X		X	331	16	3
	X	X	308	16	3
X	X	X	338	16	3

① Film Developer, 976.782 is not included; See paragraph 3.2.1

② Special Spaceflight Skill xxx.xxx is not included; See Fig. 3-2

3.2.4 Earth Observations Payloads Skills Summary

The data which has resulted from the skills analysis makes it quite apparent that availability of the Occupational Skills required on orbit should present no major problem insofar as the EO payloads encompassed by this study are concerned, whether these payloads are orbited individually or in combination. In addition, indications are favorable that other Earth Observations payloads could be added without severely constraining the availability of needed skills. The question which cannot yet be answered, though, is whether the number of needed skills can be appropriately matched with the numerical crew complement. This, of course, will be dependent on factors such as permissible crew size, total workload, simultaneous tasks, etc. Nevertheless, advance planning and study can proceed with confidence that availability of the identified Mission Occupational Skills should be adequate to accomplish all predicted tasks for these Earth Observations missions without long-lead time, specialized training.

3.3 MATERIALS SCIENCES AND MANUFACTURING PAYLOADS

Four Materials Sciences and Manufacturing experiment areas, designated for flight as Sortie Lab payloads, were analyzed in detail. These four payloads included nine (9) experiments, eight (8) of which were included in this analysis, as follows:

- MS-1 Biological Experiments
 - (1) Separation of Biologicals
 - (2) Preservation of Biologicals (not included)

- MS-2 Levitation Experiments
 - (1) Glasses
 - (2) Supercooling and Homogeneous Nucleation
 - (3) "Some" Crystals
- MS-3 Furnace Experiments
 - (1) Composite Experiments
 - (2) Directional Solidification
- MS-4 Small and Low Temperature Experiments
 - (1) Physics of Fluids
 - (2) Zone Refining

The Preservation of Biologicals experiment (MS-1(2)) was not included in the analysis of skill requirements, since all indications were that it would not be present on any of the early Sortie-Lab missions.

3.3.1 Task Statement Screening

The Crew Function Worksheets, an example of which is included in Figure 2-6, were first screened to eliminate duplications of task statements and to delete any "out of guideline" tasks. The methods and rationale used in this screening were the same as for the Earth Observations experiments, described in paragraph 3.2.1.

3.3.2 Task/Skill Requirements Analysis

Task statements remaining after screening was complete were entered onto the Task/Skill Requirements analysis sheets. One of the MS analysis sheets is illustrated in Figure 3-3; the complete set of analysis sheets for the Materials Sciences experiments is included in Appendix H, a separate volume of this report. Crew function codes and operating environment codes were taken directly from the Crew Function Worksheets. Primary and secondary task dependencies were identified according to the methodology previously described (see Section 2.2), and an appropriate Task-Skill title was entered. The task-skill title chosen in each case was one which best characterized the function being performed and the interface, or dependent, factors. Subsequently, the Task-Skill titles were correlated to Primary Occupational skill titles on a one-for-one basis.

3.3.3 Materials Sciences Skill Requirements

3.3.3.1 Biological Experiments (MS-1)

Experiments included in this payload were:

- (1) Separation of Biologicals
- (2) Preservation of Biologicals

As stated above, only the separation experiment (Electrophoresis) was included in the Task/Skill Requirements analysis.

FLIGHT EXPERIMENT TASK/SKILL REQUIREMENTS

DISCIPLINE: MATERIALS SCIENCES AND MANUFACTURING				FPE: MS-1 Materials Sciences and Manufacturing in Space				MISSION MODE: A - Shuttle Sortie			
EXPERIMENT AREA: Sortie Lab Payload MS-4				EXPERIMENT: 4.0 Small and Low Temperature Experiments 4.1 Convection of Fluids				BASIC FUNCTION: 04 - Experiment Setup			
CREW TASK STATEMENT		CREW FUNCT. NO.	OPER. ENVIR. NO.	TASK DEPENDENCY NO.		TASK - SKILL		PRIMARY OCCUPATIONAL SKILL		REFERENCE NOTE NO.	
NO.	DESCRIPTION			PRIMARY	SECONDARY	TITLE	NO.	NO.	TITLE		
32	(Continued)	15	01	2.B.06-8	2.A.39-1 3.I.08 2.C.27	Interferometer Control Actuator	1616	003.281	Instrumentation Technician		
		26	01	2.A.39-1	2.B.06-8 2.D.13-1 2.D.13-2 2.D.13-3 3.I.08 2.C.27	Interferometer Remover	1604	003.181	Electrical Technician		
		27	01	2.A.39-1	2.B.05-8 2.D.13-1 2.D.13-2 2.D.13-3 3.I.08 2.C.27	Interferometer Installer	1601	003.181	Electrical Technician		
35	Calibrate instruments	08	01	2.D.27	4.C.01	Materials Analysis Equipment Calibrator	1046	710.881	Calibrator		
		08	01	2.D.18	4.C.01	Dispersion Control System Calibrator	2313	710.881	Calibrator		
		08	01	2.A.30-1	4.C.01	Calorimeter Calibrator	0380	710.881	Calibrator		
		08	01	2.A.39-1	4.C.01	Interferometer Calibrator	1605	710.881	Calibrator		
37	Define apparatus configuration	11	01	3.I.08	2.C.27	Fluid Convection Research Evaluator	1649	023.081 022.081	Physicist, Heat Chemist, Physical		
					2.D.13-1						
					2.D.13-2						
					2.D.13-3						
					4.D.22-1						
					2.D.15						
					4.D.13						
					2.D.18						
					2.A.17-7						
					2.A.04-3						
					2.A.30-1						
					2.D.21-1						
					2.D.21-2						
					2.D.21-3						
					4.E.04-1						
					2.D.22						
					4.D.14						
(Continued on following page)											
REVISION NO:		REVISION DATE:		PREPARED BY: GRH/EMW		APPROVED BY: GRH		SERIES MS-1-A		PAGEMS-4.1-04-9	

Figure 3-3: Example of Task/Skill Requirements Analysis Data Sheet, Materials Sciences and Manufacturing

The Biologicals Separation experiment analysis resulted in the identification of 118 different task-skill titles which were correlated to eight (8) different primary occupational skills. Payload MS-1(1) task-skills and their respective primary and mission occupational skills are listed in Table 3-4. Determination of the appropriate mission occupational skills was made through skill-grouping, as described in Section 2.2. The derivation of these groupings is illustrated in Figure 3-4. As shown, the analysis leads to the conclusion that all of the experiment tasks for payload MS-1(1) can be accomplished by a crew complement with the following Occupational Skills:

- #003.281 Instrumentation Technician
- #041.081 Biochemist
- #828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training may be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. It should be understood that the identification of the three MOSs does not necessarily represent a crew complement of three individuals, one with each MOS. Until such time as detailed experiment timelines, workload analyses, sequence definitions, etc., can be accomplished, such a conclusion would be invalid.

3.3.3.2 Levitation Experiments (MS-2)

Experiments included in this payload, according to Sortie Lab references, were:

- (1) Glasses
- (2) Supercooling
- (3) "Some" Crystals

Since there were no previously documented experiment descriptions which conform directly with these titles, a comparison was made to documented experiments in order to determine those which would be suitable for purposes of task and skill requirements analysis. As a result, the following three experiments were selected:

- (1) Glass Processing: Preparation of Glasses
- (2) Crystal Growth: Supercooling and Homogeneous Nucleation
- (3) Crystal Growth: Crystal Growth from Solutions

3.3.3.2.1 Preparation of Glasses (MS-2(1))

Analysis of this experiment resulted in the identification of 165 different task-skill titles which were correlated to eight (8) different primary occupational skills. Payload MS-2(1) task-skills and their respective primary occupational skills are listed in Table 3-4, together with the primary and mission occupational skills for other portions of payload MS-2 and other MS payloads. The derivation of these skill groupings, which was accomplished at the total payload (MS-2) level, is illustrated in Figure 3-4.

Love

*No Occupational Skill Assigned; see text, paragraph 3.2.1

Table 3-4, p. 1' of 9

TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
CODE	TITLE	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.187	003.281	011.281	022.081	023.081	041.081	710.884	722.281	828.281																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment

6A10S Assigned to #022.081, Physical Chemist on Combined Payloads.

Table 3-4, p. 2 of 9

TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
CODE	TITLE	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.187	003.281	011.281	022.081	023.081	041.081	710.884	722.281	828.281																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

**TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)**

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS																							
CODE	TITLE	PAYLOADS/EXPERIMENTS								CODE	OCCUPATIONAL SKILLS																						
		MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)		000.000	General Technical Skill	003.181	Electrical Technician	003.187	Radio Engineer	003.281	Instrumentation Technician	011.281	Metallurgist Assistant	022.081	Chemist, Inorganic	022.081	Chemist, Physical	023.081	Physicist, Heat	041.081	Biochemist	710.884	Calibrator	722.281	Inspector, Systems	828.281
1229	Holographic Device Control Actuator																																
1232	Holographic Device Repairer																																
1233	Holographic Device Fault Identifier																																
1234	Holographic Device Module Installer																																
1235	Holographic Device Module Remover																																
1236	Holographic Device Stower																																
1237	Holographic Device Remover																																
1238	Holographic Device Installer																																
1239	Holographic Device Translocator																																
1240	Holographic Device Unstower																																
1241	Heating/Cooling Device Operation Monitor																																
1242	Heating/Cooling Device Control Actuator																																
1245	Heating/Cooling Device Repairer																																
1246	Heating/Cooling Device Fault Identifier																																
1250	Heating/Cooling Device Remover																																
1251	Heating/Cooling Device Installer																																
1252	Heating/Cooling Device Translocator																																
1253	Heating/Cooling Device Unstower																																
1254	Metal Sample Installer																																
1255	Metal Sample Remover																																
1256	Metal Sample Translocator																																
1257	Metal Sample Unstower																																
1259	Heating/Positioning Coil Operation Monitor																																
1260	Heating/Positioning Coil Control Actuator																																
1263	Heating/Positioning Coil Repairer																																
1264	Heating/Positioning Coil Fault Identifier																																
1267	Heating/Positioning Coil Stower																																
1268	Heating/Positioning Coil Remover																																
1269	Heating/Positioning Coil Installer																																
1270	Heating/Positioning Coil Translocator																																
1271	Heating/Positioning Coil Unstower																																
1333	Heating/Positioning Coil Calibrator																																
1336	Heating/Positioning Coil Cleaner																																
1341	Metal Sample Stower																																
1343	Atmosphere Analysis Unit Operation Monitor																																
1345	TV Camera Operation Monitor																																
1346	Liquid Dispersion Research Planner																																
1347	Slip Formulation Controller																																
1348	Slip Materials Stower																																
1351	Slip Materials Remover																																
1353	Liquid Dispersion Research Evaluator																																
1354	Materials Sample Unstower																																
1355	Materials Sample Translocator																																
1356	Materials Sample Installer																																
1357	Materials Sample Remover																																
1358	Slip Casting Remover																																
1359	Slip Casting Stower																																
1360	Immiscible System Casting Stower																																
1361	Slip Cast Injection System Cleaner																																
1362	Immiscible System Casting Remover																																
1363	Slip Cast Injection System Controller																																

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS												
CODE	TITLE									CODE												
		MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)		000.000	003.181	003.187	003.281	011.281	022.081	022.081	023.081	041.081	710.884	722.281	828.281
1370	Materials Dopant Installer																					
1371	Materials Sample Stower																					
1372	Silicate Melt Susceptor Control Actuator																					
1373	Silicate Melt Susceptor Unstower																					
1374	Silicate Melt Susceptor Translocator																					
1375	Silicate Melt Susceptor Installer																					
1376	Silicate Melt Susceptor Remover																					
1377	Silicate Melt Susceptor Module Remover																					
1378	Silicate Melt Susceptor Module Installer																					
1394	Crystal Growth Research Evaluator																					
1395	Silicate Melt Susceptor Fault Identifier																					
1396	Silicate Melt Susceptor Repairer																					
1398	Silicate Solvent Applier																					
1400	Furnace Control Deactuator																					
1401	Silicate Melt Susceptor Operating Monitor																					
1405	Zone Melter Control Actuator																					
1406	Zone Melter Unstower																					
1407	Zone Melter Translocator																					
1408	Zone Melter Installer																					
1410	Zone Melter Module Remover																					
1411	Zone Melter Module Installer																					
1412	Zone Melter Cleaner																					
1413	Zone Melter Operation Monitor																					
1415	Crystal Puller Control Actuator																					
1416	Crystal Puller Unstower																					
1417	Crystal Puller Translocator																					
1418	Crystal Puller Installer																					
1419	Crystal Puller Remover																					
1422	Crystal Puller Cleaner																					
1423	Crystal Puller Operation Monitor																					
1425	Zone Refiner Control Actuator																					
1426	Zone Refiner Unstower																					
1427	Zone Refiner Translocator																					
1428	Zone Refiner Installer																					
1430	Zone Refiner Module Remover																					
1431	Zone Refiner Module Installer																					
1432	Zone Refiner Cleaner																					
1433	Zone Refiner Operation Monitor																					
1436	Zone Refiner Fault Identifier																					
1437	Zone Refiner Repairer																					
1439	Zone Melter Fault Identifier																					
1440	Zone Melter Repairer																					
1442	Crystal Puller Fault Identifier																					
1443	Crystal Puller Repairer																					
1444	Crystal Growth Characteristics Determiner																					
1445	Crystal Growth Structure Analyzer																					
1446	Test Cell Installer																					
1447	Materials Analysis Equipment Tester																					
1448	Camera Tester																					
1449	Holographic Device Tester																					
1454	Crystal Growth Data Recorder																					
1455	Densitometer Unstower																					
1456	Densitometer Translocator																					
1457	Densitometer Installer																					
1458	Densitometer Remover																					

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

**TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)**

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS									
CODE	TITLE	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.187	003.281	011.281	022.081	022.081	023.081	041.081
		Separation of Biologicals	Preparation of Classes	Supercool'g/Homog. Nuclea.	Crystal Growth/Solutions	Composite Materials	Liquid Dispersions	Fluids Convection	Crystal Growth/Melts	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Physicist, Heat	Biochemist	Calibrator
1461	Densitometer Calibrator	△												×					
1462	Densitometer Operation Monitor	△												×					
1465	Densitometer Fault Identifier	△												×					
1466	Densitometer Repairer	△												×					
1474	Calorimeter Repairer			△				△						×					
1479	Calorimeter Remover			△				△						×					
1480	Calorimeter Installer			△				△			○			×					
1481	Calorimeter Translocator			△				△			○			×					
1482	Calorimeter Unstower			△				△			○			×					
1483	Friction Measuring Device Repairer			△				△						×					
1484	Friction Measuring Device Fault Identifier			△				△						×					
1487	Friction Measuring Device Operation Monitor			△				△						×					
1488	Friction Measuring Device Calibrator			△				△						×					
1491	Friction Measuring Device Remover			△				△				○		×				○	
1492	Friction Measuring Device Installer			△				△				○		×					
1493	Friction Measuring Device Translocator			△				△			○			×					
1494	Friction Measuring Device Unstower			△				△						×					
1495	Friction Measuring Device Control Deactuator			△				△						×					
1496	Friction Measuring Device Control Actuator			△				△						×					
1497	Friction Measuring Device Stower			△				△						×					
1498	Friction Measuring Device Cleaner			△				△						×					
1499	Calorimeter Stower			△				△						×					
1500	Calorimeter Cleaner			△				△						×					
1505	Heating/Positioning Coil Control Deactuator			△				△						×					
1507	Atmosphere Analysis Unit Control Deactuator			△				△						×					
1508	Holographic Device Control Deactuator			△				△						×					
1509	VHF Power Unit Control Deactuator			△				△						×					
1512	Crystal Growth Process Monitor			△				△						○	×				
1513	Glass Samples Unstower			△				△						×					
1514	Glass Samples Translocator			△				△			○			×					
1515	Glass Samples Installer			△				△			○			×					
1516	Glass Samples Remover			△				△			○			×					
1517	Glass Samples Stower			△				△						×					
1518	Glass Structure Analyzer			△				△						○	×				
1519	Data Recorder Unstower	△	△	△	△		△	△	△		○			×					
1520	Data Recorder Translocator	△	△	△	△		△	△	△		○			×					
1521	Glass Processing Research Planner		△											○	×				
1522	Glass Processing Research Evaluator		△											○	×				
1524	Gas Elimination/Cooling System Installer	△									○			×					
1525	Gas Elimination/Cooling System Unstower	△									○			×					
1526	Gas Elimination/Cooling System Translocator	△									○			×					
1527	Gas Elimination/Cooling System Cleaner	△									○			×					
1528	Gas Elimination/Cooling System Stower	△									○			×					
1529	Gas Elimination/Cooling System Operation Monitor	△									○			×					
1534	Gas Elimination/Cooling System Fault Identifier	△												×					
1535	Gas Elimination/Cooling System Repairer	△												×					
1536	Cleanup/Refurbishment Equipment Installer	△									○			×					
1537	Cleanup/Refurbishment Equipment Unstower	△									○			×					
1538	Cleanup/Refurbishment Equipment Translocator	△									○			×					
1539	Cleanup/Refurbishment Equipment Stower	△									○			×					
1540	Buffer/Waste Separator Installer	△									○			×					
1541	Buffer/Waste Separator Unstower	△									○			×					
1542	Buffer/Waste Separator Translocator	△									○			×					
1543	Buffer/Waste Separator Cleaner	△									○			×					
1544	Buffer/Waste Separator Stower	△									○			×					

○ = Primary Occupational Skill. × = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS												
CODE	TITLE	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.187	003.281	011.281	022.081	022.081	023.081	041.081	710.884	722.281	828.281
1545	Buffer/Waste Separator Operation Monitor	△																				
1548	Buffer/Waste Separator Fault Identifier	△																				
1549	TV System Control Actuator		△																			
1550	Data Compression Equipment Control Actuator		△																			
1551	Buffer Solution Installer	△																				
1552	Buffer Solution Unstower	△																				
1553	Buffer Solution Translocator	△																				
1554	Buffer Solution Remover	△																				
1555	Buffer Solution Mixing Controller	△																				
1556	Biological Materials Installer	△																				
1557	Biological Materials Unstower	△																				
1558	Biological Materials Translocator	△																				
1559	Biological Materials Remover	△																				
1560	Biological Enclosure Unstower	△																				
1562	Biological Enclosure Stower	△																				
1563	Biological Enclosure Operation Monitor	△																				
1568	Biological Enclosure Fault Identifier	△																				
1569	Biological Enclosure Repairer	△																				
1572	Buffer/Waste Separator Repairer	△																				
1573	Electrophoretic Column Installer	△																				
1574	Electrophoretic Column Unstower	△																				
1575	Electrophoretic Column Translocator	△																				
1576	Electrophoretic Column Remover	△																				
1577	Electrophoretic Column Cleaner	△																				
1578	Electrophoretic Column Stower	△																				
1579	Electrophoretic Column Operation Monitor	△																				
1584	Electrophoretic Column Fault Identifier	△																				
1585	Electrophoretic Column Repairer	△																				
1586	Electrophoretic Separation Research Planner	△				△																
1587	Electrophoretic Separation Process Evaluator	△																				
1588	Electrophoretic Separation Data Recorder	△																				
1589	Lyophilization Apparatus Control Actuator	△																				
1598	Ampoule Installer	△				△																
1601	Interferometer Installer	△																				
1602	Interferometer Unstower	△																				
1603	Interferometer Translocator	△																				
1604	Interferometer Remover	△																				
1605	Interferometer Calibrator	△																				
1606	Interferometer Tester	△																				
1607	Interferometer Stower	△																				
1608	Interferometer Controller	△																				
1609	Interferometer Operation Monitor	△																				
1614	Interferometer Fault Identifier	△																				
1615	Interferometer Repairer	△																				
1616	Interferometer Control Actuator	△																				
1617	Densitometer Control Actuator	△																				
1618	Densitometer Tester	△																				
1619	Densitometer Stower	△																				
1620	Densitometer Controller	△																				
1621	Buffer/Waste Separator Remover	△																				
1622	Gas Elimination/Cooling System Remover	△																				
1623	Buffer Solution Flow Rate Determiner	△																				
1624	Biological Materials Test Observer	△																				
1625	Electrophoretic Separation Research Evaluator	△																				
1626	Biological Materials Mixing Controller	△																				

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

MOS Assigned to #022.081, Physical Chemist on Combined Payloads

Table 3-4, p. 7 of 9

**TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)**

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS									
CODE	TITLE	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.187	003.281	011.281	022.081	022.081	023.081	041.081
1647	Fluid Sample Mixing Controller																		
1648	Fluid Convection Research Planner																		
1649	Fluid Convection Research Evaluator																		
1650	Fluid Samples Installer																		
1651	Fluid Samples Translocator																		
1652	Fluid Samples Unstower																		
1653	Fluid Samples Remover																		
1986	Atmosphere Supply/Control System Inspector																		
1987	Atmosphere Supply/Control System Tester																		
2060	TV System Tester																		
2068	TV System Control Deactuator																		
2238	Biological Materials Separation Planner																		
2239	Electrophoretic Separation Research Coordinator																		
2240	Instrumentation & Control Center Unstower																		
2241	Ampoule Remover																		
2242	Densitometer Inspector																		
2243	Interferometer Inspector																		
2244	Buffer Solution Stower																		
2245	Biological Materials Stower																		
2246	Instrumentation & Control Center Stower																		
2247	Buffer Solution Flow Rate Observer																		
2248	Electrophoretic Column Control Actuator																		
2249	Biological Materials Data Determiner																		
2250	Instrumentation & Control Center Fault Identifier																		
2251	Instrumentation & Control Center Repairer																		
2252	General Purpose Lab Bench Unstower																		
2253	Accident Control System Unstower																		
2254	Glass Processing Research Coordinator																		
2255	Instrumentation & Control Center Control Actuator																		
2256	General Purpose Lab Bench Stower																		
2257	Silicate Melt Susceptor Stower																		
2258	Accident Control System Stower																		
2259	Line Reader Installer																		
2260	General Purpose Lab Bench Control Actuator																		
2261	Accident Control System Control Actuator																		
2262	Viewing Device Control Actuator																		
2263	Glass Processing Research Monitor																		
2264	Accident Control System Operation Monitor																		
2265	General Purpose Lab Bench Fault Identifier																		
2266	General Purpose Lab Bench Repairer																		
2267	Accident Control System Fault Identifier																		
2268	Accident Control System Repairer																		
2269	Materials Analysis Equipment Inspector																		
2270	Holographic Device Inspector																		
2271	Environmental Chamber Inspector																		
2272	Power Conditioning/Distribution System Inspector																		
2273	Calorimeter Inspector																		
2274	Friction Measuring Device Inspector																		
2275	Atmosphere Analysis Unit Inspector																		
2276	Chill System Inspector																		
2277	Heat Rejection System Inspector																		
2278	Heating/Positioning Coils Inspector																		
2279	Viewing Device Inspector																		
2280	VHF Power Unit Inspector																		
2281	Accident Control System Inspector																		

☐ = Primary Occupational Skill. ☒ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

*MOS Assigned to #022.081, Physical Chemist on Combined Payloads.

Table 3-4, p. 8 of 9

**TABLE 3-4: Correlation of Task-Skills with Payloads and Occupational Skills, Sortie Lab
Multi-Experiment Materials Science Payload (MS-1, MS-2, MS-3, MS-4).
(Continued)**

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS											
CODE	TITLE	MS-1(1)	MS-2(1)	MS-2(2)	MS-2(3)	MS-3(1)	MS-3(2)	MS-4(1)	MS-4(2)	CODE	000.000	003.181	003.187	003.281	011.281	022.081	023.081	041.081	710.884	722.281	828.281
2282	General Purpose Lab Bench Inspector																				
2283	Environmental Chamber Tester																				
2284	Power Conditioning/Distribution System Tester																				
2285	Calorimeter Tester																				
2286	Friction Measuring Device Tester																				
2287	Atmosphere Analysis Unit Tester																				
2288	Chill System Tester																				
2290	Heat Rejection System Tester																				
2291	Heating/Positioning Coil Tester																				
2292	Viewing Device Tester																				
2293	VHF Power Unit Tester																				
2294	Accident Control System Tester																				
2295	Computer Tester																				
2296	Viewing Device Control Deactuator																				
2297	Chill System Control Deactuator																				
2298	Crystal Growth Research Coordinator																				
2299	Crystal Growth Process Observer																				
2300	Materials Sample Structure Analyzer																				
2301	Metal Sample Structure Analyzer																				
2302	Glass Sample Structure Analyzer																				
2303	Crystal Growth Research Monitor																				
2304	Materials Dopant Translocator																				
2305	Materials Dopant Unstower																				
2306	Heating/Cooling Device Cleaner																				
2307	Heating/Cooling Device Control Deactuator																				
2308	Sample Holder Remover																				
2309	Composite Materials Research Coordinator																				
2310	Dispersion Control System Translocator																				
2311	Dispersion Control System Installer																				
2312	Dispersion Control System Remover																				
2313	Dispersion Control System Calibrator																				
2314	Composite Materials Sample Evaluator																				
2315	Composite Materials Research Monitor																				
2316	Immiscible Liquid Sample Remover																				
2317	Immiscible Liquid Sample Installer																				
2318	Slip Casting Translocator																				
2319	Immiscible System Casting Translocator																				
2320	Liquid Dispersions Research Coordinator																				
2321	Mixing Equipment Controller																				
2322	Slip Materials Installer																				
2323	Casting Mold Disassembler																				
2324	Casting Mold Installer																				
2325	Liquid Dispersion Research Status Determiner																				
2326	Liquid Dispersion Research Monitor																				
2327	Slip Cast Injection System Control Actuator																				
2328	Fluid Connection Research Coordinator																				
2329	Fluid Connection Research Monitor																				
2330	Test Cell Translocator																				
2331	Test Cell Unstower																				
2332	Peltier Heater Control Actuator																				
2333	Crystal Growth Data Observer																				
2334	Crystal Growth Data Interpreter																				
2335	Crystal Sample Installer																				
2336	Microscope Controller																				
2337	Zone Melter Controller																				
	All Material Sciences Payloads																				

☐ = Primary Occupational Skill. ☒ = Mission Occupational Skill. ☒ = Task-Skill Required by Payload/Experiment.

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

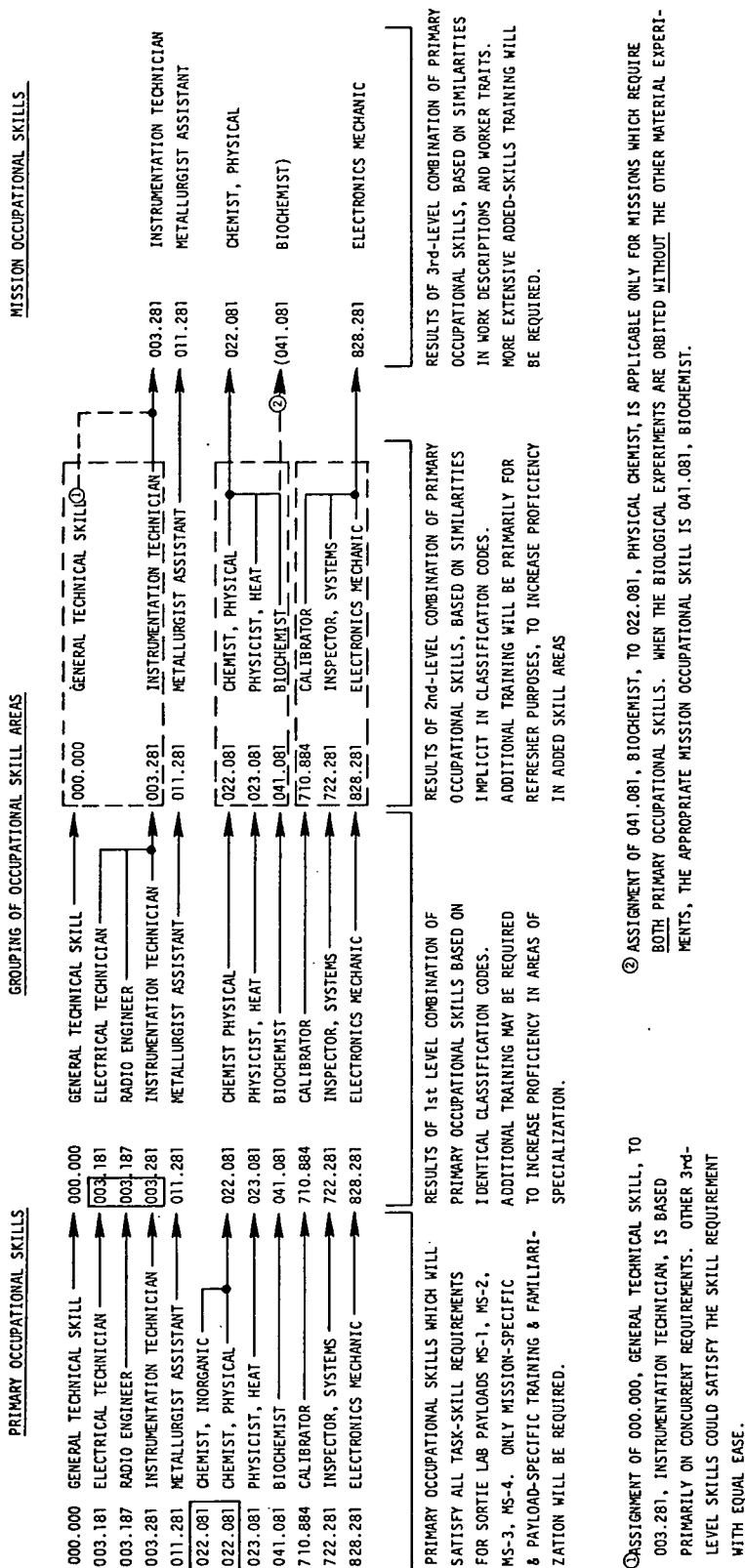


Figure 3-4: Derivation of Mission Occupational Skills for Sortie Lab Material Sciences Payloads MS-1, MS-2, MS-3, and MS-4

3.3.3.2.2 Supercooling and Homogeneous Nucleation (MS-2(2))

Analysis of this experiment resulted in the identification of 224 different task-skill titles which were correlated to nine (9) different occupational skills. As explained in paragraph 3.3.3.2.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

3.3.3.2.3 Crystal Growth from Solutions (MS-2(3))

Analysis of this experiment resulted in the identification of 157 different task-skill titles which were correlated to eight (8) different occupational skills. As explained in paragraph 3.3.3.2.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

3.3.3.2.4 Levitation Experiments Combined (MS-2)

Analysis of all experiments in this payload resulted in the identification of 285 different task-skill titles which were correlated to nine (9) different occupational skills. As explained in paragraph 3.3.3.2.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively. The skill grouping methodology is described in Section 2.2. The analysis of the three experiments in this payload leads to the conclusion that all the tasks required by the experiments can be accomplished by a crew-complement with the following Occupational Skills:

- #003.281 Instrumentation Technician
- #011.281 Metallurgist Assistant
- #022.081 Chemist, Physical
- #828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. Also, as previously discussed, this listing is for a complement of occupational skills and does not necessarily represent a crew of four individuals.

3.3.3.3 Furnace Experiments (MS-3)

Experiments included in this payload, according to Sortie Lab references, were:

- (1) Composite Materials
- (2) Directional Solidification

Although the "Composite Materials" experiment was easily identified, and previously described (Ref. 6), there was no previously described experiment under the title of "Directional Solidification". A comparison of apparent requirements, implicit in the title, led to the selection of a documented experiment which would be suitable for purposes of task and skill requirements

analyses. As a result, the two experiments analyzed for this payload were:

- (1) Metallurgical Processes: Composite Materials
- (2) Metallurgical Processes: Liquid Dispersions

3.3.3.3.1 Composite Materials (MS-3(1))

Analysis of this experiment resulted in the identification of 130 different task-skill titles which were correlated to seven (7) different occupational skills. Payload MS-3(1) task-skills and their respective primary occupational skills are listed in Table 3-4, together with the primary and mission occupational skills for other MS payloads. The derivation of these skill groupings, which was accomplished at the total payload (MS-3) level, is illustrated in Figure 3-4.

3.3.3.3.2 Liquid Dispersions (MS-3(2))

Analysis of this experiment resulted in the identification of 166 different task-skill titles which were correlated to seven (7) different occupational skills. As explained in paragraph 3.3.3.3.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

3.3.3.3.3 Furnace Experiments Combined (MS-3)

Analysis of the two experiments in this payload resulted in the identification of 209 different task-skill titles which were correlated to eight (8) different occupational skills. As explained in paragraph 3.3.3.3.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively. The skill-grouping methodology is described in Section 2.2. The conclusion reached as a result of these analyses is that all MS-3 payload tasks can be accomplished by a crew complement with the following Occupational Skills:

- #003.281 Instrumentation Technician
- #011.281 Metallurgist Assistant
- #828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. Also, as previously discussed, this listing is for a complement of occupational skills and does not necessarily represent a crew of three individuals.

3.3.3.4 Small and Low Temperature Experiments (MS-4)

Experiments included in this payload, according to Sortie Lab references, were:

- (1) Physics of Fluids
- (2) Zone Refining

Comparison of apparent requirements, implicit in the experiment titles, led to selection of two previously described experiments which were judged suitable for purposes of task and skill requirements analysis. These experiments were:

- (1) Physical Properties of Fluids: Convection
- (2) Crystal Growth: Single Crystal Growth from Melts

3.3.3.4.1 Fluid Convection (MS-4(1))

Analysis of this experiment resulted in the identification of 138 different task-skill titles which were correlated to nine (9) different occupational skills. Payload MS-4(1) task-skills and their respective primary occupational skills are listed in Table 3-4, together with the primary and mission occupational skills for other MS payloads. The derivation of these skill groupings, which was accomplished at the total payload (MS-4) level, is illustrated in Figure 3-4.

3.3.3.4.2 Crystal Growth from Melts (MS-4(2))

Analysis of this experiment resulted in the identification of 164 different task-skill titles which were correlated to eight (8) different occupational skills. As explained in paragraph 3.3.3.4.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively, along with other MS payload data.

3.3.3.4.3 Small/Low Temperature Experiments Combined (MS-4)

Analysis of the two experiments in this payload resulted in the identification of 226 different task-skill titles which were correlated to ten (10) different occupational skills. As explained in paragraph 3.3.3.4.1, these relationships are tabulated and illustrated in Table 3-4 and Figure 3-4, respectively. The skill grouping methodology is described in Section 2.2. Subsequent to combining the results of the separate experiments in this payload, it has been concluded that all MS-4 experiment tasks can be accomplished by a crew complement with the following Occupational Skills:

- #003.281 Instrumentation Technician
- #022.081 Chemist, Physical
- #828.281 Electronics Mechanic

As noted in Figure 3-4, some cross-training will be required to adequately reflect the Primary Occupational Skills in the selected Mission Occupational Skills. Also, as previously discussed, this listing is for a complement of occupational skills and does not necessarily represent a crew of three individuals.

3.3.3.5 Multiexperiment Materials Sciences Payloads

Although the task and skills analyses for the encompassed Materials Sciences payloads were accomplished at the designated payload (by experiment) level, it is quite

possible that a specific Materials Sciences mission will include more than one of the separate payloads. Thus, MS-1 and MS-3 may be orbited together, as may be any other combination of the four payloads (MS-1, MS-2, MS-3, MS-4). It is also possible that one or more of the MS payloads may be joined by one or more compatible payloads from other MS research areas, or even from other disciplines (e.g., Astronomy, Physics, etc.). Assuming that combinations of payloads MS-1, MS-2, MS-3, and MS-4 were feasible, based on parameters other than skills, a determination was made of the extent of skill commonality with these payloads in various combinations. As can be seen from examination of Table 3-4, task-skill commonality is significant across experiments and payloads, especially when the primary task dependency (from which the task-skill is derived) is an equipment interface. Commonality is lower in those task-skills where a specific area of knowledge is the determinant, but still occurs frequently.

Even more significant, as is shown in Table 3-5, even though the number of required task-skills for the four payloads combined increases to 564, the number of Primary Occupational Skills only increases to a maximum of twelve (12), all of which can be grouped into four Mission Occupational Skills:

- #003.281 Instrumentation Technician
- #011.281 Metallurgist Assistant
- #022.081 Chemist, Physical
- #828.281 Electronics Mechanic

These, of course, are the same four Mission Occupational Skills required for payload MS-2 alone. The obvious conclusion to be reached, in terms of skill requirements, is that payload MS-2 should be the nucleus of any recombinations of Materials Sciences payloads into a new payload. It should also be pointed out, as noted in Figure 3-4, that Occupational Skill #041.081, Biochemist, is the MOS of choice only for MS-1 payloads alone or when skill #022.081, Physical Chemist, is not required by the payload experiment.

Cross-training requirements obviously will be greatly increased in order to accommodate all task-skill requirements in these multiple payloads. There is little additional impact on skill requirements when a multiple payload with two of the original payloads is increased to accommodate three or all four payloads. This is especially true if one of the two initial payloads is MS-2, Levitation Experiments.

A further possibility is that specific experiments within the designated payloads may be combined in a different manner to make up a different payload. While this is recognized as possible, the effect on combinations of skills was not specifically explored. This data can be determined, however, from the listings in Table 3-4.

3.3.4 Materials Sciences Payloads Skills Summary

The data which has resulted from the skills analysis make it quite apparent that availability of the Occupational Skills required on orbit should present no major problem insofar as the MS payloads encompassed by this study are concerned. This should be true whether the payloads are orbited individually

TABLE 3-5: Comparison of Single Experiment-Area Payloads to Multiple Experiment-Area Payloads, MS Missions.

PAYLOADS				Number of Task Skills	Number of Preliminary Occupational Skills ①	Number of Mission Occupational Skills
MS - 1	MS - 2	MS - 3	MS - 4			
X				118	8	3
	X			285	9	4
		X		209	8	3
			X	226	10	3
X	X			375	10	4 ②
X		X		300	9	4
X			X	311	11	3 ②
	X	X		367	9	4
	X		X	370	11	4
		X	X	309	11	4
X	X	X		453	10	4 ②
X	X		X	449	12	4 ②
X		X	X	388	12	4 ②
	X	X	X	418	11	4
X	X	X	X	495	12	4 ②

- (1) Film Developer, 976.782, is not included; see paragraph 3.3.1
- (2) When other payloads are in combination with MS-1, #022.081, Physical Chemist (when available) can satisfy requirements for #041.081, Biochemist. See Figure 3-4.

or in combination. In addition, indications are favorable that other Materials Sciences payloads could be added without severely constraining the availability of needed skills. The question which cannot yet be answered, though, is whether the number of needed skills can be appropriately matched with the numerical crew complement. This, of course, will be dependent on factors such as permissible crew size, total workload, simultaneous tasks, etc. Nevertheless, advance planning and study can proceed with confidence that availability of the identified Mission Occupational Skills should be adequate to accomplish all predicted tasks for these Materials Sciences and Manufacturing missions without long-lead time, specialized training.

3.4 General Summary of Skill Requirements Analyses

The skill analyses conducted under this contract have included seven payloads in two entirely different research areas, comprising eleven separate experiments. Collectively, this has resulted in the identification of 819 task-skills which can be expected to be required during the conduct of these missions. Twenty one (21) different Primary Occupational Skills were identified which can satisfy the requirements of all of the designated task-skills, and these, in turn, can be grouped into five (5) Mission Occupational Skills. Because of the disparity between research objectives, gravity constraints, etc., of the two research areas, it is unlikely that any Sortie Lab mission would attempt combinations of Earth Observations and Materials Sciences payloads, although this could become a reality in the more distant Space Station program.

The composite of all task-skills identified in support of this study, together with the related payloads, Primary Occupational Skills, and Mission Occupational Skills, is presented in Table 3-6 for reference. A total listing of task-skills identified to date (NASw-2192; NAS8-28359) is included as Appendix E to this report. A composite list of Task Dependencies, used in deriving the Task-Skills, is included as Appendix D. Definitions and descriptions of each identified Occupational Skill, extracted from References 20 and 21, are included as Appendix F.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.

TASK - SKILL		PAYLOADS/EXPERIMENTS						OCCUPATIONAL SKILLS																				
CODE	TITLE	EO-3 Air & Water Pollution	EO-4 Resources Recognition	EO-5 Disaster Assessment	MS-1 Biological Experiments	MS-2 Levitation Experiments	MS-3 Furnace Experiments	MS-4 Small/Low Temperature Exp.	CODE	003.181 Electrical Technician	003.187 Radio Engineer	003.187 Systems Engineer, EDP	003.281 Instrumentation Technician	007.081 Optical Technician	011.281 Metallurgist Assistant	018.188 Surveyor, Geodetic	022.081 Chemist, Inorganic	022.081 Chemist, Physical	023.081 Physicist, Heat	024.081 Geologist	024.081 Geophysicist	025.088 Meteorologist	025.288 Weather Observer	041.081 Biochemist	710.884 Calibrator	714.684 Camera Inspector	722.281 Inspector, Systems	828.281 Electronics Mechanic
0001	Telescope Inspector								1																			
0004	Telescope Optics Cleaner																											
0026	TV Camera Translocator																											
0036	Spectrometer Control Actuator																											
0038	Spectrometer Fault Identifier																											
0039	Camera Installer																											
0040	Spectrometer Tester																											
0046	Film Cartridge Installer																											
0054	TV Camera Unstower																											
0064	TV Camera Stower																											
0072	Spectrometer Calibrator																											
0079	TV Camera Inspector																											
0095	Spectrometer Optics Cleaner																											
0096	TV Camera Optics Cleaner																											
0097	Camera Lens (Optics) Cleaner																											
0109	Spectrometer Module Remover																											
0110	Spectrometer Module Installer																											
0111	TV Camera Module Remover																											
0112	TV Camera Module Installer																											
0158	Camera Module Remover																											
0160	Camera Module Installer																											
0187	Telescope Module Remover																											
0188	Telescope Module Installer																											
0204	Camera Mode Monitor																											
0206	Radio Communicator																											
0209	Scanner Mode Monitor																											
0212	TV Camera Mode Monitor																											
0245	Camera Control Actuator																											
0265	Telescope Mode Selector																											
0267	Spectrometer Mode Selector																											
0268	TV Mode Selector																											
0271	Camera Mode Selector																											
0292	Camera Unstower																											
0294	Camera Inspector																											
0297	Telescope Aligner																											
0303	Telescope Unstower																											
0306	TV Camera Installer																											
0314	Camera Remover																											
0320	Telescope Control Deactuator																											
0328	Film Processor *																											
0334	TV Camera Controller																											
0335	Camera Controller **																											
0336	Spectrometer Controller **																											
0337	Telescope Controller **																											
0345	TV System Module Remover																											
0346	TV System Module Installer																											
0376	Calorimeter Fault Identifier																											
0380	Calorimeter Calibrator																											
0391	Calorimeter Operation Monitor																											
0392	Calorimeter Control Actuator																											
0393	Calorimeter Control Deactuator																											
0409	Spectrometer Control Deactuator																											
0516	Meteorological Condition Observer																											

¹General Technical Skill, 000.000, Assigned..²Special Spaceflight Skill, XXX.XXX, Assigned.

Table 3-6, p. 1 of 15

*No Occupational Skill Assigned; see text, paragraph 3.2.1

⑥ The skill listings for each payload, individually, are included in Appendix C.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS																			
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.281	007.081	011.281	018.188	022.081	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281	
0523	Computer Fault Identifier																												
0540	Computer Repairer																												
0611	Radar Transmitter Unstower																												
0613	Radar Transmitter Tester																												
0615	Radar Transmitter Module Remover																												
0616	Radar Transmitter Module Installer																												
0623	Radar Receiver Module Installer																												
0624	Radar Receiver Module Remover																												
0627	Radar Receiver Tester																												
0628	Radar Transmitter Unstower																												
0633	TV Camera Tester																												
0637	Radiometer Module Installer																												
0638	Radiometer Module Remover																												
0641	Radiometer Tester																												
0642	Radiometer Unstower																												
0644	Radiometer Mode Monitor																												
0653	Polarimeter Mode Monitor																												
0661	TV Camera Remover																												
0662	Telemetry Equipment Control Actuator																												
0664	Radar Transmitter Control Deactuator																												
0666	Radar Receiver Control Deactuator																												
0672	TV Camera Control Deactuator																												
0673	Radiometer Control Deactuator																												
0683	Radar Transmitter Fault Identifier																												
0684	Radar Transmitter Repairer																												
0685	Radar Receiver Fault Identifier																												
0686	Radar Receiver Repairer																												
0689	TV Camera Fault Identifier																												
0690	TV Camera Repairer																												
0691	Radiometer Fault Identifier																												
0692	Radiometer Repairer																												
0779	Spectrometer Repairer																												
0787	Spectrometer Mode Monitor																												
0795	Electronic Equipment Fault Identifier																												
0812	Radar Transmitter Operation Monitor																												
0823	Scanner Unstower																												
0825	Sferics Detector Unstower																												
0828	Scanner Inspector																												
0829	Radiometer Inspector																												
0831	Polarimeter Inspector																												
0832	Sferics Detector Inspector																												
0833	Spectrometer Inspector																												
0837	Radiometer Calibrator																												
0842	Scanner Control Actuator																												
0843	Radiometer Control Actuator																												
0844	Polarimeter Control Actuator																												
0845	Sferics Detector Control Actuator																												
0846	Telescope Control Actuator																												
0847	Computer Control Actuator																												
0848	Camera Control Deactuator																												
0849	Scanner Control Deactuator																												
0852	Film Stower																												
0853	Sferics Detector Control Deactuator																												
0862	Tape Recorder Controller																												
0869	Scanner Data Quality Monitor																												
[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment																													

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment

¹ General Technical Skill, 000.000, Assigned.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS						OCCUPATIONAL SKILLS																				
		EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.281	007.081	011.281	018.188	022.081	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281
CODE	TITLE																											
0870	Radiometer Data Quality Monitor																											
0872	Spectrometer Data Quality Monitor																											
0873	Polarimeter Data Quality Monitor																											
0874	Telescope Operation Evaluator																											
0875	Camera Operation Evaluator																											
0876	Scanner Operation Evaluator																											
0877	Radiometer Operation Evaluator																											
0879	Spectrometer Operation Evaluator																											
0880	Polarimeter Operation Evaluator																											
0882	Sferics Detector Data Quality Monitor																											
0884	Scanner Optics Cleaner																											
0885	Telescope Fault Identifier																											
0886	Camera Fault Identifier																											
0887	Scanner Fault Identifier																											
0888	Scatterometer Fault Identifier																											
0889	Polarimeter Fault Identifier																											
0890	Sferics Detector Fault Identifier																											
0891	Optical Equipment Fault Identifier																											
0895	Telescope Presentation Observer																											
0896	TV Presentation Observer																											
0897	Scanner Presentation Observer																											
0898	Radiometer Presentation Observer																											
0899	TV Camera Control Actuator																											
0904	Scanner Module Remover																											
0905	Scanner Module Installer																											
0908	Polarimeter Module Remover																											
0909	Polarimeter Module Installer																											
0914	Polarimeter Presentation Observer																											
0915	Spectrometer Presentation Observer																											
0916	Scanner Mode Selector																											
0917	Radiometer Mode Selector																											
0918	Polarimeter Mode Selector																											
0919	Polarimeter Control Deactuator																											
0921	Telescope Pointing Controller **																											
0922	TV Data Quality Monitor																											
0923	TV Camera Operation Evaluator																											
0924	Radiometer Optics Cleaner																											
0925	Polarimeter Optics Cleaner																											
0926	Earth Survey C/D Equipment Module Remover																											
0927	Earth Survey C/D Equipment Module Installer																											
0928	Earth Survey C/D Equipment Fault Identifier																											
0932	Radar Transmitter Inspector																											
0933	Radar Receiver Inspector																											
0934	Radar Presentation Observer																											
0935	Radar Transmitter Control Actuator																											
0936	Radar Receiver Control Actuator																											
0937	Sferics Detector Presentation Observer																											
0938	Radar Transmitter Mode Selector																											
0939	Radar Receiver Mode Selector																											
0940	Sferics Detector Mode Selector																											
0941	Forest Fire Disaster Identifier																											
0942	Telescope Mode Monitor																											
0943	Telescope Mode Recorder																											
0944	Radar Data Quality Monitor																											
0945	Sferics Detector Optics Cleaner																											

[0] = Primary Occupational Skill. [X] = Mission Occupational Skill. [A] = Task-Skill Required by Payload/Experiment

[0] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment

¹General Technical Skill, 000.000, Assigned.

**No Mission Occupational Skill Assigned; see text and Figure 3-2.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS / EXPERIMENTS						OCCUPATIONAL SKILLS																																								
CODE	TITLE	EO-3 Air & Water Pollution	EO-4 Resources Recognition	MS-1 Disaster Assessment	MS-2 Biological Experiments	MS-2 Levitation Experiments	MS-3 Furnace Experiments	MS-4 Small/Low Temperature Exp.	CODE	003.181	Electrical Technician	003.187	Radio Engineer	003.187	Systems Engineer, EDP	003.281	Instrumentation Technician	007.081	Optical Technician	011.281	Metallogist Assistant	018.188	Surveyor, Geodetic	022.081	Chemist, Inorganic	022.081	Chemist, Physical	023.081	Physicist, Heat	024.081	Geologist	024.081	Geophysicist	025.088	Meteorologist	075.288	Weather Observer	041.081	Biochemist	710.884	Calibrator	714.684	Camera Inspector	722.281	Inspector, Systems	020.281	Electronics Mechanic	
0946	Sferics Detector Module Remover																																															
0947	Sferics Detector Module Installer																																															
0968	Composite Materials Research Planner																																															
0969	Composite Materials Data Recorder																																															
0971	Composite Materials Structure Analyzer																																															
0973	Composite Materials Research Evaluator																																															
0974	Composite Materials Sample Installer																																															
0975	Composite Materials Sample Unstower																																															
0976	Composite Materials Sample Translocator																																															
0977	Composite Materials Sample Remover																																															
0978	Composite Materials Sample Stower																																															
0980	Furnace Unstower																																															
0981	Furnace Module Remover																																															
0982	Furnace Module Installer																																															
0983	Furnace Stower																																															
0984	Furnace Cleaner																																															
0985	Furnace Operation Monitor																																															
0988	Furnace Repairer																																															
0989	Furnace Fault Identifier																																															
0991	Mixing Unit Installer																																															
0992	Mixing Unit Unstower																																															
0993	Mixing Unit Translocator																																															
0994	Mixing Unit Remover																																															
0997	Mixing Unit Stower																																															
0998	Mixing Unit Cleaner																																															
0999	Mixing Unit Operation Monitor																																															
1002	Mixing Unit Repairer																																															
1003	Mixing Unit Fault Identifier																																															
1016	Materials Forming Equipment Installer																																															
1017	Materials Forming Equipment Unstower																																															
1018	Materials Forming Equipment Translocator																																															
1021	Materials Forming Equipment Cleaner																																															
1046	Materials Analysis Equipment Calibrator																																															
1048	Materials Analysis Equipment Cleaner																																															
1049	Materials Analysis Equipment Controller																																															
1054	Computer Unstower																																															
1055	Computer Operation Monitor																																															
1058	Environmental Chamber Unstower																																															
1059	Environmental Chamber Module Remover																																															
1060	Environmental Chamber Module Installer																																															
1061	Environmental Chamber Stower																																															
1062	Environmental Chamber Cleaner																																															
1065	Environmental Chamber Repairer																																															
1066	Environmental Chamber Fault Identifier																																															
1067	Chill System Installer																																															
1068	Chill System Unstower																																															
1069	Chill System Translocator																																															
1070	Chill System Remover																																															
1073	Chill System Stower																																															
1074	Chill System Operation Monitor																																															
1077	Chill System Repairer																																															
1078	Chill System Fault Identifier																																															
1079	Vibrator Installer																																															
1080	Vibrator Unstower																																															
1081	Vibrator Calibrator																																															

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment.

¹General Technical Skill, 000.000, Assigned.

Table 3-6, p. 4 of 15

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS						OCCUPATIONAL SKILLS																							
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.187	003.281	007.081	011.281	018.188	022.081	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281		
1082	Vibrator Remover																														
1085	Vibrator Stower																														
1086	Vibrator Operation Monitor																														
1089	Vibrator Repairer																														
1090	Vibrator Fault Identifier																														
1091	VHF Power Unit Installer																														
1092	VHF Power Unit Unstower																														
1093	VHF Power Unit Translocator																														
1094	VHF Power Unit Remover																														
1095	VHF Power Unit Module Remover																														
1096	VHF Power Unit Module Installer																														
1097	VHF Power Unit Calibrator																														
1098	VHF Power Unit Stower																														
1099	VHF Power Unit Operation Monitor																														
1102	VHF Power Unit Repairer																														
1103	VHF Power Unit Fault Identifier																														
1104	Telemetry Equipment Controller																														
1105	Dispersion Control System Unstower																														
1107	Dispersion Control System Stower																														
1109	Dispersion Control System Cleaner																														
1110	Dispersion Control System Operation Monitor																														
1113	Dispersion Control System Repairer																														
1114	Dispersion Control System Fault Identifier																														
1115	Slip Cast Injection System Installer																														
1116	Slip Cast Injection System Unstower																														
1117	Slip Cast Injection System Translocator																														
1118	Slip Cast Injection System Remover																														
1122	Slip Cast Injection System Operation Monitor																														
1125	Slip Cast Injection System Repairer																														
1126	Slip Cast Injection System Fault Identifier																														
1127	Atmosphere Supply/Control System Module Remover																														
1128	Atmosphere Supply/Control System Module Installer																														
1129	Atmosphere Supply/Control System Operation Monitor																														
1132	Atmosphere Supply/Control System Repairer																														
1133	Atmosphere Supply/Control System Fault Identifier																														
1134	Power Conditioning/Distribution Sys. Module Remover																														
1135	Power Conditioning/Distribution Sys. Module Installer																														
1136	Power Conditioning/Distribution Sys. Oper. Mon.																														
1139	Power Conditioning/Distribution System Repairer																														
1140	Power Conditioning/Distribution Sys. Fault Identifier																														
1141	Environmental Chamber Operation Monitor																														
1142	Heat Rejection System Unstower																														
1145	Heat Rejection System Stower																														
1146	Heat Rejection System Operation Monitor																														
1149	Heat Rejection System Repairer																														
1150	Heat Rejection System Fault Identifier																														
1156	Data Recorder Installer																														
1160	Computer Stower																														
1162	Atmosphere Supply/Control System Unstower																														
1163	Power Conditioning/Distribution System Unstower																														
1169	Atmosphere Supply/Control System Stower																														
1170	Power Conditioning/Distribution System Stower																														
1173	Environmental Chamber Control Actuator																														
1174	Atmosphere Supply/Control System Control Actuator																														
1175	Furnace Control Actuator																														
[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [A] = Task-Skill Required by Payload/Experiment.																															

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment.

¹ General Technical Skill, 000.000, Assigned.

Table 3-6, p. 5 of 15



PAPER

☐ = Primary Occupational Skill. ☒ = Mission Occupational Skill. = Task-Skill Required by Payload/Experiment.

¹General Technical Skill, 000.000, Assigned.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS																					
CODE	TITLE	EO-3 Air & Water Pollution	EO-4 Resources Recognition	EO-5 Disaster Assessment	MS-1 Biological Experiments	MS-2 Levitation Experiments	MS-3 Furnace Experiments	MS-4 Small/Low Temperature Exp.	CODE	003.181 Electrical Technician	003.187 Radio Engineer	003.187 Systems Engineer, EDP	003.281 Instrumentation Technician	007.081 Optical Technician	011.281 Metallurgist Assistant	018.188 Surveyor, Geodetic	022.081 Chemist, Inorganic	022.081 Chemist, Physical	023.081 Physicist, Heat	024.081 Geologist	024.081 Geophysicist	025.088 Meteorologist	025.288 Weather Observer	041.081 Biochemist	710.884 Calibrator	714.684 Camera Inspector	722.281 Inspector, Systems	928.281 Electronics Mechanic
1264	Heating/Positioning Coil Fault Identifier																											
1267	Heating/Positioning Coil Stower																											
1268	Heating/Positioning Coil Remover																											
1269	Heating/Positioning Coil Installer																											
1270	Heating/Positioning Coil Translocator																											
1271	Heating/Positioning Coil Unstower																											
1333	Heating/Positioning Coil Calibrator																											
1336	Heating/Positioning Coil Cleaner																											
1341	Metal Sample Stower																											
1343	Atmosphere Analysis Unit Operation Monitor																											
1344	Camera Operation Monitor																											
1345	TV Camera Operation Monitor																											
1346	Liquid Dispersion Research Planner																											
1347	Slip Formulation Controller																											
1348	Slip Materials Stower																											
1351	Slip Materials Remover																											
1353	Liquid Dispersion Research Evaluator																											
1354	Materials Sample Unstower																											
1355	Materials Sample Translocator																											
1356	Materials Sample Installer																											
1357	Materials Sample Remover																											
1358	Slip Casting Remover																											
1359	Slip Casting Stower																											
1360	Immiscible System Casting Stower																											
1361	Slip Cast Injection System Cleaner																											
1362	Immiscible System Casting Remover																											
1363	Slip Cast Injection System Controller																											
1366	Sample Holder Installer																											
1367	Crystal Growth Research Planner																											
1368	Crystal Growth Observer																											
1369	Crystal Growth Process Evaluator																											
1370	Materials Dopant Installer																											
1371	Materials Sample Stower																											
1372	Silicate Melt Susceptor Control Actuator																											
1373	Silicate Melt Susceptor Unstower																											
1374	Silicate Melt Susceptor Translocator																											
1375	Silicate Melt Susceptor Installer																											
1376	Silicate Melt Susceptor Remover																											
1377	Silicate Melt Susceptor Module Remover																											
1378	Silicate Melt Susceptor Module Installer																											
1394	Crystal Growth Research Evaluator																											
1395	Silicate Melt Susceptor Fault Identifier																											
1396	Silicate Melt Susceptor Repairer																											
1398	Silicate Solvent Applier																											
1400	Furnace Control Deactuator																											
1401	Silicate Melt Susceptor Operating Monitor																											
1405	Zone Melter Control Actuator																											
1406	Zone Melter Unstower																											
1407	Zone Melter Translocator																											
1408	Zone Melter Installer																											
1410	Zone Melter Module Remover																											
1411	Zone Melter Module Installer																											
1412	Zone Melter Cleaner																											
1413	Zone Melter Operation Monitor																											
1415	Crystal Puller Control Actuator																											

[O]= Primary Occupational Skill. [X]= Mission Occupational Skill. [A] = Task-Skill Required by Payload/Experiment.

[0] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment.

¹General Technical Skill, 000.000, Assigned.

Table 3-6, p. 7 of 15

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS							OCCUPATIONAL SKILLS																			
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.281	007.081	011.281	018.188	022.081	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281
1416	Crystal Puller Unstower								1																			
1417	Crystal Puller Translocator																											
1418	Crystal Puller Installer																											
1419	Crystal Puller Remover																											
1422	Crystal Puller Cleaner																											
1423	Crystal Puller Operation Monitor																											
1425	Zone Refiner Control Actuator																											
1426	Zone Refiner Unstower																											
1427	Zone Refiner Translocator																											
1428	Zone Refiner Installer																											
1430	Zone Refiner Module Remover																											
1431	Zone Refiner Module Installer																											
1432	Zone Refiner Cleaner																											
1433	Zone Refiner Operation Monitor																											
1436	Zone Refiner Fault Identifier																											
1437	Zone Refiner Repairer																											
1439	Zone Melter Fault Identifier																											
1440	Zone Melter Repairer																											
1442	Crystal Puller Fault Identifier																											
1443	Crystal Puller Repairer																											
1444	Crystal Growth Characteristics Determiner																											
1445	Crystal Growth Structure Analyzer																											
1446	Test Cell Installer																											
1447	Materials Analysis Equipment Tester																											
1448	Camera Tester																											
1449	Holographic Device Tester																											
1454	Crystal Growth Data Recorder																											
1455	Densitometer Unstower																											
1456	Densitometer Translocator																											
1457	Densitometer Installer																											
1458	Densitometer Remover																											
1461	Densitometer Calibrator																											
1462	Densitometer Operation Monitor																											
1465	Densitometer Fault Identifier																											
1466	Densitometer Repairer																											
1474	Calorimeter Repairer																											
1479	Calorimeter Remover																											
1480	Calorimeter Installer																											
1481	Calorimeter Translocator																											
1482	Calorimeter Unstower																											
1483	Friction Measuring Device Repairer																											
1484	Friction Measuring Device Fault Identifier																											
1487	Friction Measuring Device Operation Monitor																											
1488	Friction Measuring Device Calibrator																											
1491	Friction Measuring Device Remover																											
1492	Friction Measuring Device Installer																											
1493	Friction Measuring Device Translocator																											
1494	Friction Measuring Device Unstower																											
1495	Friction Measuring Device Control Deactuator																											
1496	Friction Measuring Device Control Actuator																											
1497	Friction Measuring Device Stower																											
1498	Friction Measuring Device Cleaner																											
1499	Calorimeter Stower																											
1500	Calorimeter Cleaner																											
1505	Heating/Positioning Coil Control Deactuator																											

[-] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment.

0 = Primary Occupational Skill. X = Mission Occupational Skill. Δ = Task-Skill Required by Payload/Experiment.

¹General Technical Skill, 000.000, Assigned.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS							OCCUPATIONAL SKILLS																			
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.281	007.081	011.281	018.188	022.081	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281
1507	Atmosphere Analysis Unit Control Deactuator																											
1508	Holographic Device Control Deactuator																											
1509	VHF Power Unit Control Deactuator																											
1512	Crystal Growth Process Monitor																											
1513	Glass Samples Unstower																											
1514	Glass Samples Translocator																											
1515	Glass Samples Installer																											
1516	Glass Samples Remover																											
1517	Glass Samples Stower																											
1518	Glass Structure Analyzer																											
1519	Data Recorder Unstower																											
1520	Data Recorder Translocator																											
1521	Glass Processing Research Planner																											
1522	Glass Processing Research Evaluator																											
1524	Gas Elimination/Cooling System Installer																											
1525	Gas Elimination/Cooling System Unstower																											
1526	Gas Elimination/Cooling System Translocator																											
1527	Gas Elimination/Cooling System Cleaner																											
1528	Gas Elimination/Cooling System Stower																											
1529	Gas Elimination/Cooling System Operation Monitor																											
1534	Gas Elimination/Cooling System Fault Identifier																											
1535	Gas Elimination/Cooling System Repairer																											
1536	Cleanup/Refurbishment Equipment Installer																											
1537	Cleanup/Refurbishment Equipment Unstower																											
1538	Cleanup/Refurbishment Equipment Translocator																											
1539	Cleanup/Refurbishment Equipment Stower																											
1540	Buffer/Waste Separator Installer																											
1541	Buffer/Waste Separator Unstower																											
1542	Buffer/Waste Separator Translocator																											
1543	Buffer/Waste Separator Cleaner																											
1544	Buffer/Waste Separator Stower																											
1545	Buffer/Waste Separator Operation Monitor																											
1548	Buffer/Waste Separator Fault Identifier																											
1549	TV System Control Actuator																											
1550	Data Compression Equipment Control Actuator																											
1551	Buffer Solution Installer																											
1552	Buffer Solution Unstower																											
1553	Buffer Solution Translocator																											
1554	Buffer Solution Remover																											
1555	Buffer Solution Mixing Controller																											
1556	Biological Materials Installer																											
1557	Biological Materials Unstower																											
1558	Biological Materials Translocator																											
1559	Biological Materials Remover																											
1560	Biological Enclosure Unstower																											
1562	Biological Enclosure Stower																											
1563	Biological Enclosure Operation Monitor																											
1568	Biological Enclosure Fault Identifier																											
1569	Biological Enclosure Repairer																											
1572	Buffer/Waste Separator Repairer																											
1573	Electrophoretic Column Installer																											
1574	Electrophoretic Column Unstower																											
1575	Electrophoretic Column Translocator																											
1576	Electrophoretic Column Remover																											
1577	Electrophoretic Column Cleaner																											

[-] = Primary Occupational Skill. [X] = Mission Occupational Skill. [] = Task-Skill Required by Payload/Experiment.

[0] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS						OCCUPATIONAL SKILLS											
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	Electrical Technician	Radio Engineer	Systems Engineer - EDP	Instrumentation Technician	Optical Technician	Metallurgist Assistant	Surveyor - Geodetic	Chemist - Inorganic	Chemist - Physical	Physicist - Heat
1578	Electrophoretic Column Stower								003.181										
1579	Electrophoretic Column Operation Monitor								003.187										
1584	Electrophoretic Column Fault Identifier								003.187										
1585	Electrophoretic Column Repairer								003.281										
1586	Electrophoretic Separation Research Planner								007.081										
1587	Electrophoretic Separation Process Evaluator								011.281										
1588	Electrophoretic Separation Data Recorder								018.188										
1589	Lyophilization Apparatus Control Actuator								022.081										
1598	Ampoule Installer								022.081										
1601	Interferometer Installer								023.081										
1602	Interferometer Unstower								024.081										
1603	Interferometer Translocator								024.081										
1604	Interferometer Remover								024.081										
1605	Interferometer Calibrator								024.081										
1606	Interferometer Tester								024.081										
1607	Interferometer Stower								024.081										
1608	Interferometer Controller								024.081										
1609	Interferometer Operation Monitor								024.081										
1614	Interferometer Fault Identifier								024.081										
1615	Interferometer Repairer								024.081										
1616	Interferometer Control Actuator								024.081										
1617	Densitometer Control Actuator								024.081										
1618	Densitometer Tester								024.081										
1619	Densitometer Stower								024.081										
1620	Densitometer Controller								024.081										
1621	Buffer/Waste Separator Remover								024.081										
1622	Gas Elimination/Cooling System Remover								024.081										
1623	Buffer Solution Flow Rate Determiner								024.081										
1624	Biological Materials Test Observer								024.081										
1625	Electrophoretic Separation Research Evaluator								024.081										
1626	Biological Materials Mixing Controller								024.081										
1647	Fluid Sample Mixing Controller								024.081										
1648	Fluid Convection Research Planner								024.081										
1649	Fluid Convection Research Evaluator								024.081										
1650	Fluid Samples Installer								024.081										
1651	Fluid Samples Translocator								024.081										
1652	Fluid Samples Unstower								024.081										
1653	Fluid Samples Remover								024.081										
1986	Atmosphere Supply/Control System Inspector								024.081										
1987	Atmosphere Supply/Control System Tester								024.081										
2045	TV Camera Mode Recorder								024.081										
2046	Scanner Mode Recorder								024.081										
2047	Radiometer Mode Recorder								024.081										
2048	Polarimeter Mode Recorder								024.081										
2049	Spectrometer Mode Recorder								024.081										
2050	Camera Status Monitor								024.081										
2051	Time Elapsed Observer**								024.081										
2052	TV Camera Status Monitor								024.081										
2053	Atmospheric Pollution Data Observer								024.081										
2054	Water Pollution Data Observer								024.081										
2055	Water Pollution Data Evaluator								024.081										
2056	Atmospheric Pollution Data Evaluator								024.081										
2057	Meteorological Conditions Evaluator								024.081										
2058	Mission Events Evaluator**								024.081										
2059	TV System Inspector								024.081										

[0] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment

¹General Technical Skill, 000.000, Assigned. ²Special Spaceflight Skill, XXX.XXX, Assigned. Table 3-6, p. 10 of 15

**No Mission Occupational Skill Assigned; see text and Figure 3-2.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS							OCCUPATIONAL SKILLS																		
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.281	007.081	011.281	018.188	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281
2060	TV System Tester																										
2061	Scanner Tester																										
2062	Polarimeter Tester																										
2063	Polarimeter Aligner																										
2064	TV System Fault Identifier																										
2065	Earth Survey C/D Equipment Repairer																										
2066	Scanner Repairer																										
2067	Polarimeter Repairer																										
2068	TV System Control Deactuator																										
2076	TV Data Classifier																										
2077	Scanner Data Classifier																										
2078	Radiometer Data Classifier																										
2079	Polarimeter Data Classifier																										
2080	Spectrometer Data Classifier																										
2081	Polarimeter Controller **								2																		
2082	TV Data Analyzer																										
2083	Scanner Data Analyzer																										
2084	Radiometer Data Analyzer																										
2085	Polarimeter Data Analyzer																										
2086	Spectrometer Data Analyzer																										
2087	Telescope Data Analyzer																										
2088	Scanner Adequacy Determiner																										
2089	TV Camera Adequacy Determiner																										
2090	Radiometer Adequacy Determiner																										
2091	Polarimeter Adequacy Determiner																										
2092	Telescope Adequacy Determiner																										
2093	Camera Adequacy Determiner																										
2094	TV System Operation Monitor																										
2095	Scanner Operation Monitor																										
2096	Radiometer Operation Monitor																										
2097	Polarimeter Operation Monitor																										
2098	Spectrometer Operation Monitor																										
2099	Telescope Operation Monitor																										
2100	Atmospheric Pollution Data Classifier																										
2101	Water Pollution Data Classifier																										
2102	Video Data Quality Evaluator																										
2103	Radar Transmitter Mode Monitor																										
2104	Radar Receiver Mode Monitor																										
2105	Radar Transmitter Mode Recorder																										
2106	Radar Receiver Mode Recorder																										
2107	Land Use Data Observer																										
2108	Land Use Data Evaluator																										
2109	Radar Data Classifier																										
2110	Telescope Data Classifier																										
2111	Spectrometer Adequacy Determiner																										
2112	Radar Transmitter Adequacy Determiner																										
2113	Radar Receiver Adequacy Determiner																										
2114	Radar Operation Monitor																										
2115	Land Use Data Classifier																										
2116	Earth Surface Landmark Observer																										
2117	Earth Surface Landmark Classifier																										
2118	Sferics Detector Mode Monitor																										
2119	Sferics Detector Mode Recorder																										
2120	Camera Mode Recorder																										
2121	Geological Precursor Data Observer																										

0 = Primary Occupational Skill. X = Mission Occupational Skill. [] = Task-Skill Required by Payload/Experiment.

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

²Special Spaceflight Skill, XXX.XXX, Assigned.

Table: 3-6, p. 11 of 15

**No Mission Occupational Skill Assigned; see text and Figure 3-2.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS						OCCUPATIONAL SKILLS											
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Metallurgist Assistant	Surveyor, Geodetic	Chemist, Inorganic	Chemist, Physical	Physicist, Heat
2122	Geological Precursor Data Evaluator								003.181										
2123	Earthquake Data Observer								003.187										
2124	Earthquake Data Evaluator								003.187										
2125	Sferics Detector Tester								003.281										
2126	Telescope Tester								007.081										
2127	Sferics Detector Adequacy Determiner								011.281										
2128	Meteorological Precursor Data Observer								018.188										
2129	Artificial Precursor Data Observer								022.081										
2130	Topographical Precursor Data Observer								022.081										
2131	Precursor Disaster Data Observer								023.081										
2132	Meteorological Precursor Data Evaluator								024.081										
2133	Artificial Precursor Data Evaluator								024.081										
2134	Topographical Precursor Data Evaluator								025.088										
2135	Precursor Disaster Data Evaluator								025.288										
2136	Hurricane Data Observer								041.081										
2137	Tornado Data Observer								710.884										
2138	Tidal Wave Data Observer								714.684										
2139	Flood Data Observer								722.281										
2140	Volcanic Eruption Data Observer								828.281										
2141	Forest Fire Data Observer																		
2142	Range Fire Data Observer																		
2143	Landslide Data Observer																		
2144	Snowslide Data Observer																		
2145	Land Subsidence Data Observer																		
2146	Drought Data Observer																		
2147	Blizzard Data Observer																		
2148	Hurricane Data Evaluator																		
2149	Tornado Data Evaluator																		
2150	Tidal Wave Data Evaluator																		
2151	Flood Data Evaluator																		
2152	Volcanic Eruption Data Evaluator																		
2153	Forest Fire Data Evaluator																		
2154	Range Fire Data Evaluator																		
2155	Landslide Data Evaluator																		
2156	Snowslide Data Evaluator																		
2157	Land Subsidence Data Evaluator																		
2158	Drought Data Evaluator																		
2159	Blizzard Data Evaluator																		
2160	Geological Precursor Observer																		
2161	Meteorological Precursor Observer																		
2162	Artificial Precursor Observer																		
2163	Topographical Precursor Observer																		
2164	Precursor Disaster Observer																		
2165	Geological Precursor Classifier																		
2166	Meteorological Precursor Classifier																		
2167	Artificial Precursor Classifier																		
2168	Topographical Precursor Classifier																		
2169	Precursor Disaster Classifier																		
2170	Sferics Detector Data Classifier																		
2171	Earthquake Disaster Predictor																		
2172	Hurricane Disaster Predictor																		
2173	Tornado Disaster Predictor																		
2174	Tidal Wave Disaster Predictor																		
2175	Flood Disaster Predictor																		
2176	Volcanic Eruption Disaster Predictor																		

0 = Primary Occupational Skill. X = Mission Occupational Skill. □ = Task-Skill Required by Payload/Experiment.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS								OCCUPATIONAL SKILLS																		
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.281	007.081	011.281	018.188	022.081	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281
2177	Forest Fire Disaster Predictor																											
2178	Range Fire Disaster Predictor																											
2179	Landslide Disaster Predictor																											
2180	Snowslide Disaster Predictor																											
2181	Land Subsidence Disaster Predictor																											
2182	Drought Disaster Predictor																											
2183	Blizzard Disaster Predictor																											
2184	TV Camera Mode Selector																											
2185	Radar Receiver Operation Monitor																											
2186	Sferics Detector Operation Monitor																											
2187	Recorder Control Actuator																											
2188	Geological Precursor Data Classifier																											
2189	Meteorological Precursor Data Classifier																											
2190	Artificial Precursor Data Classifier																											
2191	Topographical Precursor Data Classifier																											
2192	Precursor Disaster Data Classifier																											
2193	Earthquake Data Classifier																											
2194	Hurricane Data Classifier																											
2195	Tornado Data Classifier																											
2196	Tidal Wave Data Classifier																											
2197	Flood Data Classifier																											
2198	Volcanic Eruption Data Classifier																											
2199	Forest Fire Data Classifier																											
2200	Range Fire Data Classifier																											
2201	Landslide Data Classifier																											
2202	Snowslide Data Classifier																											
2203	Land Subsidence Data Classifier																											
2204	Drought Data Classifier																											
2205	Blizzard Data Classifier																											
2206	Geological Precursor Communicator																											
2207	Meteorological Precursor Communicator																											
2208	Artificial Precursor Communicator																											
2209	Topographical Precursor Communicator																											
2210	Precursor Disaster Communicator																											
2211	Earthquake Disaster Communicator																											
2212	Hurricane Disaster Communicator																											
2213	Tornado Disaster Communicator																											
2214	Tidal Wave Disaster Communicator																											
2215	Flood Disaster Communicator																											
2216	Volcanic Eruption Disaster Communicator																											
2217	Forest Fire Disaster Communicator																											
2218	Range Fire Disaster Communicator																											
2219	Landslide Disaster Communicator																											
2220	Snowslide Disaster Communicator																											
2221	Land Subsidence Disaster Communicator																											
2222	Drought Disaster Communicator																											
2223	Blizzard Disaster Communicator																											
2224	Earthquake Disaster Identifier																											
2225	Hurricane Disaster Identifier																											
2226	Tornado Disaster Identifier																											
2227	Tidal Wave Disaster Identifier																											
2228	Flood Disaster Identifier																											
2229	Volcanic Eruption Disaster Identifier																											
2230	Range Fire Disaster Identifier																											
2231	Landslide Disaster Identifier																											

[0] = Primary Occupational Skill.

[X] = Mission Occupational Skill.

[X] = Task-Skill Required by Payload/Experiment.

[0] = Primary Occupational Skill. [X] = Mission Occupational Skill. [Δ] = Task-Skill Required by Payload/Experiment.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS						OCCUPATIONAL SKILLS																				
CODE	TITLE	EO-3	EO-4	EO-5	MS-1	MS-2	MS-3	MS-4	CODE	003.181	003.187	003.187	003.281	007.081	011.281	018.188	022.081	022.081	023.081	024.081	024.081	025.088	025.288	041.081	710.884	714.684	722.281	828.281
2232	Snowslide Disaster Identifier																											
2233	Land Subsidence Disaster Identifier																											
2234	Drought Disaster Identifier																											
2235	Blizzard Disaster Identifier																											
2236	Telescope Data Quality Monitor																											
2237	Sferics Detector Repairer																											
2238	Biological Materials Separation Planner																											
2239	Electrophoretic Separation Research Coordinator																											
2240	Instrumentation & Control Center Unstower																											
2241	Ampoule Remover																											
2242	Densitometer Inspector																											
2243	Interferometer Inspector																											
2244	Buffer Solution Stower																											
2245	Biological Materials Stower																											
2246	Instrumentation & Control Center Stower																											
2247	Buffer Solution Flow Rate Observer																											
2248	Electrophoretic Column Control Actuator																											
2249	Biological Materials Data Determiner																											
2250	Instrumentation & Control Center Fault Identifier																											
2251	Instrumentation & Control Center Repairer																											
2252	General Purpose Lab Bench Unstower																											
2253	Accident Control System Unstower																											
2254	Glass Processing Research Coordinator																											
2255	Instrumentation & Control Center Control Actuator																											
2256	General Purpose Lab Bench Stower																											
2257	Silicate Melt Susceptor Stower																											
2258	Accident Control System Stower																											
2259	Line Reader Installer																											
2260	General Purpose Lab Bench Control Actuator																											
2261	Accident Control System Control Actuator																											
2262	Viewing Device Control Actuator																											
2263	Glass Processing Research Monitor																											
2264	Accident Control System Operation Monitor																											
2265	General Purpose Lab Bench Fault Identifier																											
2266	General Purpose Lab Bench Repairer																											
2267	Accident Control System Fault Identifier																											
2268	Accident Control System Repairer																											
2269	Materials Analysis Equipment Inspector																											
2270	Holographic Device Inspector																											
2271	Environmental Chamber Inspector																											

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [] = Task-Skill Required by Payload/Experiment.

¹ General Technical Skill, 000.000, Assigned.

TABLE 3-6: Correlation of All EO and MS Task-Skills with Payloads and Occupational Skills.
(Continued)

[illegible]

¹General Technical Skill, 000.000, Assigned.

²Special Spaceflight Skill, XXX.XXX, Assigned.

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

SECTION 4.0

DEVELOPMENT OF WORKSTATION CONCEPTS



SECTION 4.0

DEVELOPMENT OF WORKSTATION CONCEPTS

4.1 GENERAL

This section of the report presents the results achieved in defining workstation concepts for two experiment areas. The areas selected, in common with the skills analysis portion of the study (see Section 3.0), were Earth Observations research, and Materials Sciences and Manufacturing research. No attempt was made to conceptualize a total facility for these research areas. The objective was to define the primary workstation for the experiment crew, i.e., the area with which the crew will interface most frequently and continuously, and which will be a primary driver to the orbital research facility layout.

The preliminary analysis which led to the selection of Materials Analysis experiments and Earth Observations experiments as subjects for this study is described in Section 2.0 of this report. Further, it was assumed that maximum value from the study would be realized if the task-skill/occupational skill analysis and the workstation concept development dealt with the same set of experiments and interfaces. The subject research areas, as a result, are designated Sortie Lab payloads, as follows:

Earth Observations

- EO-3: Air and Water Pollution
- EO-4: Resource Recognition
- EO-5: Disaster Assessment

Materials Sciences and Manufacturing

- MS-1: Biological Experiments
 - (1) Separation of Biologicals
- MS-2: Levitation Experiments
 - (1) Preparation of Glasses
 - (2) Supercooling and Homogeneous Nucleation
 - (3) "Some" Crystals
- MS-3: Furnace Experiments
 - (1) Composite Materials
 - (2) Directional Solidification
- MS-4: Small and Low Temperature Experiments
 - (1) Physics of Fluids
 - (2) Zone Refining

4.2 CONCEPT DEVELOPMENT APPROACH

4.2.1 Workstation Concept Development Criteria and Guidelines

The following general guidelines, constraints, and criteria were observed to the greatest extent possible:

- a) Equipment interfaces should reflect, both by their incorporation and location, the primary task dependencies identified in the Task/Skill Requirements analysis.
- b) When a specific item of experiment equipment could not be identified, either a "generalized" interface should be incorporated or a substitute with similar features should be used.
- c) Unless automation of a task was baselined, it was assumed that performance of the task would be accomplished manually, through direct interface by a crew member.
- d) Equipment and designs which were already qualified/accepted by NASA were to be used as much as possible.
- e) The approach utilized should be common for all Sortie Lab payloads/missions.
- f) The workstation should be compatible with single-crewman or multiple-crewmen operation, depending on the requirements of a specific experiment.
- g) The concept should promote rapid between-mission turnaround of the Sortie Lab module.
- h) The workstation should be compatible with other functions and activities in the Sortie Lab and the Shuttle Orbiter.

4.2.2 Conceptual Approach to Sortie Lab Workstation Development

In an attempt to satisfy the majority--and most significant--of the above guidelines, it was determined that the "workstation" for Sortie Lab research activities should be an integrated Control and Display (C/D) console. While such a console could not be expected to incorporate all possible C/D interfaces with the experimenter, across all Sortie Lab missions, it could be adequate for the majority of such interfaces. With the proper approach, such a console could permit single or multiman operation, could provide for rapid turnaround, could be efficiently reconfigured for incorporation of new experiments, and could be compatible with nonexperiment considerations of the Sortie Lab and the Shuttle Orbiter. This was achieved, conceptually, by determining that the integrated C/D Console would contain separate areas for functions relating to Sortie Lab Module Subsystems, subsystems in support of experiment payloads in general, and equipment which was specific to a particular set of payload experiments.

4.2.3 Derivation of Control/Display Functional Requirements

Having decided on a general approach to arriving at an integrated control/display console for Sortie Lab payloads, an analysis was conducted to determine the functional requirements for control and display of Earth Observations and Materials Sciences experiment operations. This was accomplished for each item of experiment equipment identified as a primary task dependency in the skills analysis portion of the study, and for some of the secondary task dependencies as well, when appropriate to development of C/D requirements. The most current descriptions available of the equipment items were used as references for functional characteristics and configuration, some from Sortie Lab documentation, and some extending as far back as the January 1971 Blue Book, and Skylab. An example of the Control/Display requirements analysis is included as Figure 4-1; documentation for the total analysis is in Appendix G.

Concurrent with this effort, other URS/Matrix studies were directed toward identifying control/display functional requirements for Sortie Lab Module and Payload Supporting Subsystems. The two efforts were merged to arrive at a more complete integrated C/D console concept. One of the results of this interfacing of the two studies is that experiment control/display requirements which were determined to be required by many payloads, in a large number of disciplines, were assigned to the Payload Support portion of the console, and were not repeated in the Experiment Support portion of the console.

4.2.4 Requirements Allocation and Concept Definition

Figure 4-2 illustrates the conceptual approach to this C/D Console, which has the following characteristics:

- A Sortie Lab "Module Support Subsystems" C/D Panel area. This portion of the workstation is essentially independent of the type of Sortie Lab missions being flown and would require no payload-related configuration changes between Sortie Lab missions. The crew interface is primarily a monitoring task, once initial activation of subsystems has been accomplished.
- A Sortie Lab "Payload Support Subsystems" C/D Panel area. This portion of the workstation comprises the central operations area for a payload specialist. Requirements analysis has indicated that some payload-related control/display requirements are common to almost all anticipated Sortie Lab missions, regardless of the nature of the experiments in the specific payload. These functions have been grouped in the central console area and, like the "Module Support Subsystems" portion of the console, they would not require interchange during Sortie Lab turnaround.
- An area below the workshelf which has the data processing equipment, electronics that need not be "behind the panel", and the central computer. These are in pull-out drawers for easy access. Figure 4-3 illustrates front and side views of the "fixed" module/payload supporting subconsole.

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS	
E-01	Continuous Atmosphere Analysis Apparatus	MS-2	2,3	Power Chromatograph on/off Spectrometer on/off	Power on Chromatograph operating status Spectrometer, operating status Impurity count Impurity type		
E-02	High Temperature Viewing Device	MS-2	3	Power Laser on/off Display adjust. Photograph actuate	Power on Laser oper. status Holographic display		
E-03	Chill System	MS-3	2	Power On/off Cooling/Coding Jet select	Power on Operating status Cooling/Cooling Jet select status Cooling Jet Warning Pump status	<ul style="list-style-type: none">• Movable unit for multiple location use; may not be susceptible to centralized C/D.• May require audible alarm.	
E-04	Motion Picture Camera (16mm)	MS-2 MS-3 MS-4	1 2 1,2	Power On/off Lens changing Focus adjust	Power on Operating status Lens in use Focus in use	<ul style="list-style-type: none">• Electrically operated• Multiple cameras planned• Movable; C/D centralization difficult.	
E-05	TV Camera	MS-1 MS-2 MS-3 MS-4	1 1 2 1,2	Power On/off Focus adjust	Power on Operating status Focus Video monitor	<ul style="list-style-type: none">• All notes same as E-04• Pan/tilt provisions unknown.	
E-06	Remote Measuring (Mass, Dimensions)	MS-2 MS-3	1,2,3 2	Power On/off	Power on Operating status	<ul style="list-style-type: none">• Description unavailable; believed to be the device for illuminating/reviewing holograms made with E-02.	

Figure 4-1: Example of Control/Display Functional Requirements Analysis

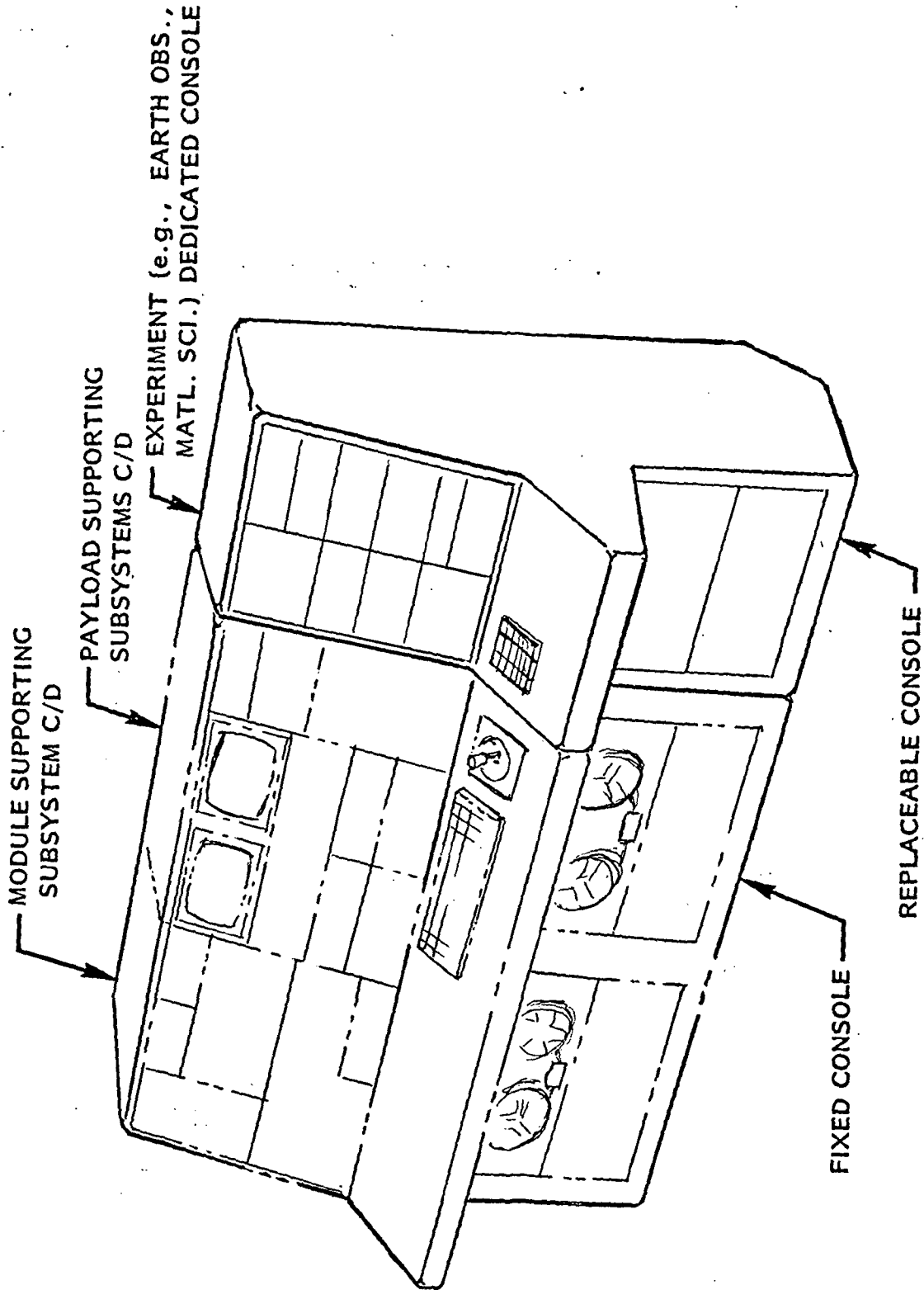
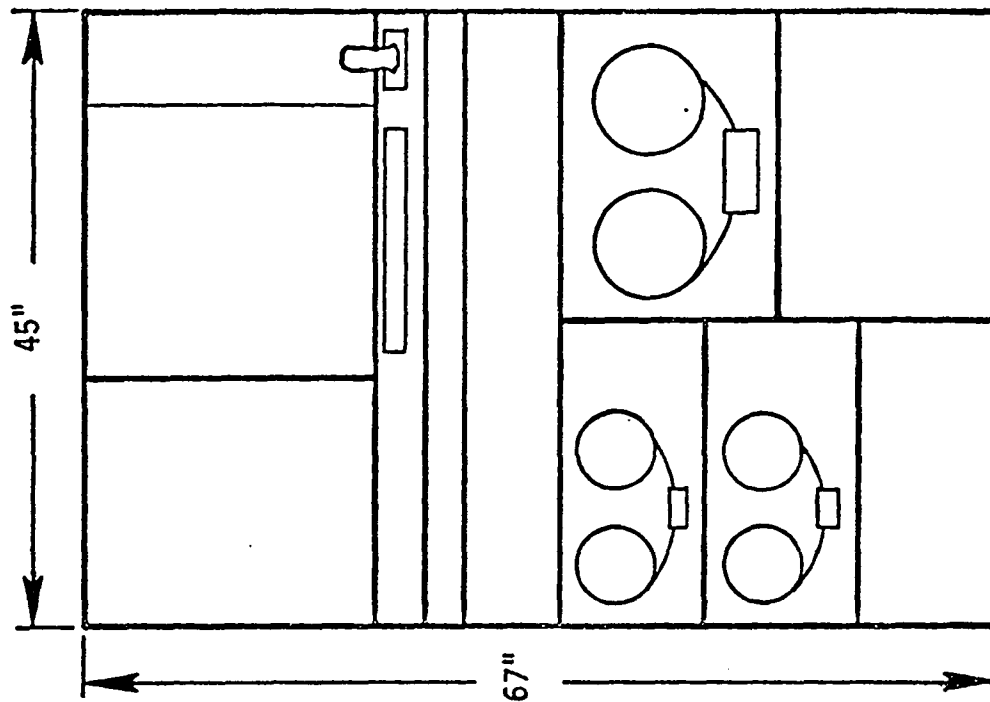


Figure 4-2: Conceptual Approach to Sortie Lab Workstation Design



Eye Reference
Point (ERP)

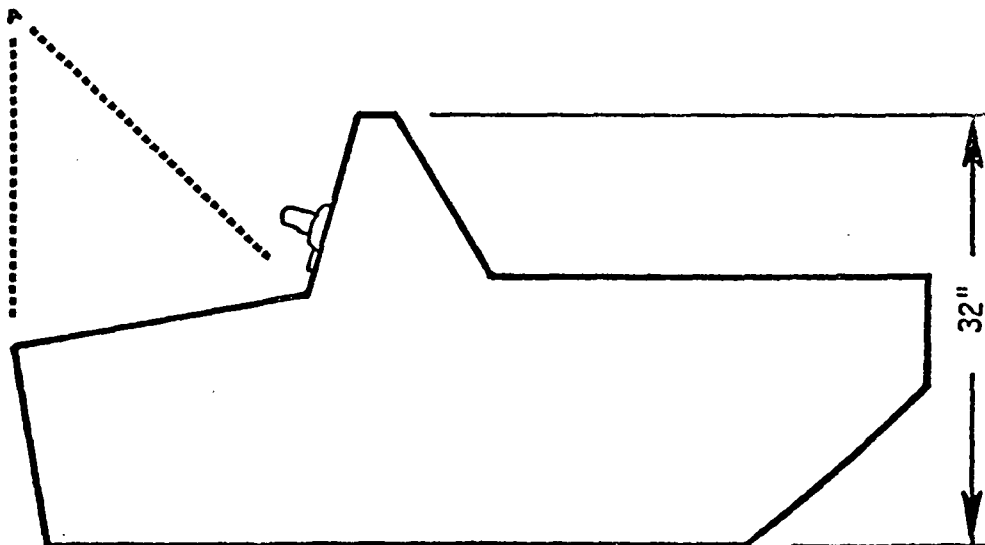


Figure 4-3: Sortie Lab Module/Payload Supporting Subsystems Control/Display Console Concept

- A separate, but physically and functionally compatible, "Experiment Support Subsystems" C/D Panel area. This subconsole is specific to the scientific/technical disciplines of the experiments comprising the payload, containing those controls and displays for experiment operations and monitoring which are amenable to incorporation in a centralized console; which have fairly common applications to experiments within the discipline; and which are not incorporated in the "Payload Support Subsystems" subconsole. This subconsole will be easily detachable from the remainder of the workstation for interchange during the between-mission turnaround.

This concept appears to represent the most feasible approach to providing centralized control and display of Sortie Lab functions, within the constraints of limited new hardware development, rapid turnaround between flights, and variable crew size and composition. It also is a realistic compromise between the competing desires of some for a totally "dedicated" C&D console, and of others for a completely "universal" C&D console. Dedicated consoles are too dependent on long-lead time training for specific individuals, and show too little between-mission commonality. A universal console is not feasible at present, primarily due to costs and unnecessary weight. Certain items of experiment-related equipment (e.g., Cloud Physics experiment) would not be represented on the consoles, if they were determined not to be amenable to a centralized console. This determination was made in the experiments analyzed whenever the experiment requirements dictated a direct physical or visual interface between the crew member and the experiment operation.

A special analysis was conducted to determine the requirements for a "workbench" as part of the Sortie Labs workstation. It was determined that while a workbench might prove useful, particularly in Materials Sciences experiments, there is no significant requirement that one be provided. This decision was reached after considering the guidelines for Sortie Lab missions, comprising little or no on-board maintenance and minimal in-flight configuration changes to equipment. The conclusion drawn from this preliminary analysis was that any requirements for a separate work surface could be met by a small, fold-down type shelf. Lengthier mission durations, with greater requirements for maintenance, repair, or configuration changes will probably require a separate workbench area. It should be noted, however, that the Task/Skill Requirements analysis for Materials Science experiments does specify the utilization of the General Purpose Lab Bench (Task Dependency #4.D.22-1) and provision is made for a C/D interface to it on the Materials Sciences subconsole (see paragraph 4.5).

4.3 MODULE/PAYLOAD SUPPORTING SUBSYSTEMS C/D CONSOLE*

Certain functions were identified in the analysis as being control/display requirement drivers. Those identified for the Module Supporting Subsystems portion of the console are listed in Table 4-1; those for the Payload Supporting Subsystems portion of the console are as follows:

*The data presented in this paragraph and in the applicable portion of Appendix G are the result of joint effort studies, performed partially under this contract and partially by other URS/Matrix studies.

Table 4-1: Module Supporting Subsystem C/D Requirements

FUNCTION	C/D REQUIREMENTS
Caution and Warning	<ul style="list-style-type: none"> • Attitude Control System • Power • Temperature • Pressure • Contamination • Radiation • Acceleration • Airlock Status
Data Management	<ul style="list-style-type: none"> • Digital Address System • Telemetry • Orbiter Interface • Voice/Video Recorders
Communications	<ul style="list-style-type: none"> • Voice • Command • Experiment Data • Computer Data • Video
Power	<ul style="list-style-type: none"> • Lighting, Thermal, etc. • Fuel Cell/Battery, Regulators • C&D Console • Experiment Console • Experiment Subsystems
Lighting	<ul style="list-style-type: none"> • C&D Console • Experiment Console • Lab
Attitude/Stability Control	<ul style="list-style-type: none"> • Shuttle Orbiter Monitor • Experiment Platform • CMGS • Star/Sun Tracker
EC/LS	<ul style="list-style-type: none"> • Thermal • Pressure • Space Radiator Deployment • Contamination • Humidity
<p>A control/display requirements analysis was performed on the above supporting subsystem; resulting data are presented in Appendix G.</p>	

PAYLOAD SUPPORTING SUBSYSTEMS REQUIREMENTS

- | | |
|-------------------------|---------------------------|
| • Data Analysis/Storage | • Manual Pointing Control |
| • Mission Time | • Airlock/Boom |
| • Event Time | • Experiment Stability |
| • Orbit Time | • Video Monitors |

Translation of these control/display requirements, for the Module Supporting Subsystems and the Payload Supporting Subsystems, resulted in the specification of definitive control/display characteristics, as itemized in Appendix G. The resulting panel layouts are illustrated in Figure 4-4.

Special mention should be made regarding the fact that Module Support and Payload Support subconsoles are permanently joined in this concept. This is primarily for ease of assembly, and to reduce the number of subconsole interconnections. If Support Module design considerations dictate that only two of the three subconsoles can be placed side-by-side, it would be preferable to have a parting plane between the Module Support and Payload Support subconsoles, and relocate the Module Support portion. It is much more necessary that the Payload Support and Experiment Support subconsoles be located together, since both are required for experiment operation.

4.4 EARTH OBSERVATIONS EXPERIMENT SUPPORT CONSOLE

An analysis was conducted of the control/display requirements for experiment equipment during Earth Observations missions. These C/D requirements are itemized in Appendix G, and they include all documented Sortie Lab EO missions. Certain C/D requirements were satisfied by incorporation in the Payload Supporting Subsystems C/D Console Panel, if high commonality with other experiment areas could be demonstrated. Other C/D requirements were so specialized (or so unique as to dictate against their incorporation into a centralized console) that they were excluded. In this latter case, it is expected that the necessary controls and displays will be on the item of experiment equipment itself, if appropriate.

The Earth Observations Experiment Support Console Panel configuration which resulted from this analysis is illustrated in Figure 4-5. Integration of the EO subconsole with the Module/Payload Support console is illustrated in Figure 4-6. Supporting analytical data, in terms of functional requirements for controls and displays during Earth Observations Sortie Lab missions, are in Appendix G. All panel features identified have been given a task dependency reference code number. The format and utilization of the task-dependency reference system is explained in Section 2.0. The complete Task Dependency Reference List is incorporated as Appendix D to this report. Earth Observations C/D task dependencies are in the 2.B.04 series of Appendix D. A cross-reference between EO experiment equipment, C/D panels, and experiments, is included in Appendix G.

4.5 MATERIALS SCIENCES EXPERIMENT SUPPORT CONSOLE

Similarly to the Earth Observations workstation concept development (paragraph 4.4), an analysis was performed to determine the requirements for experiment equipment controls and displays during Materials Sciences and

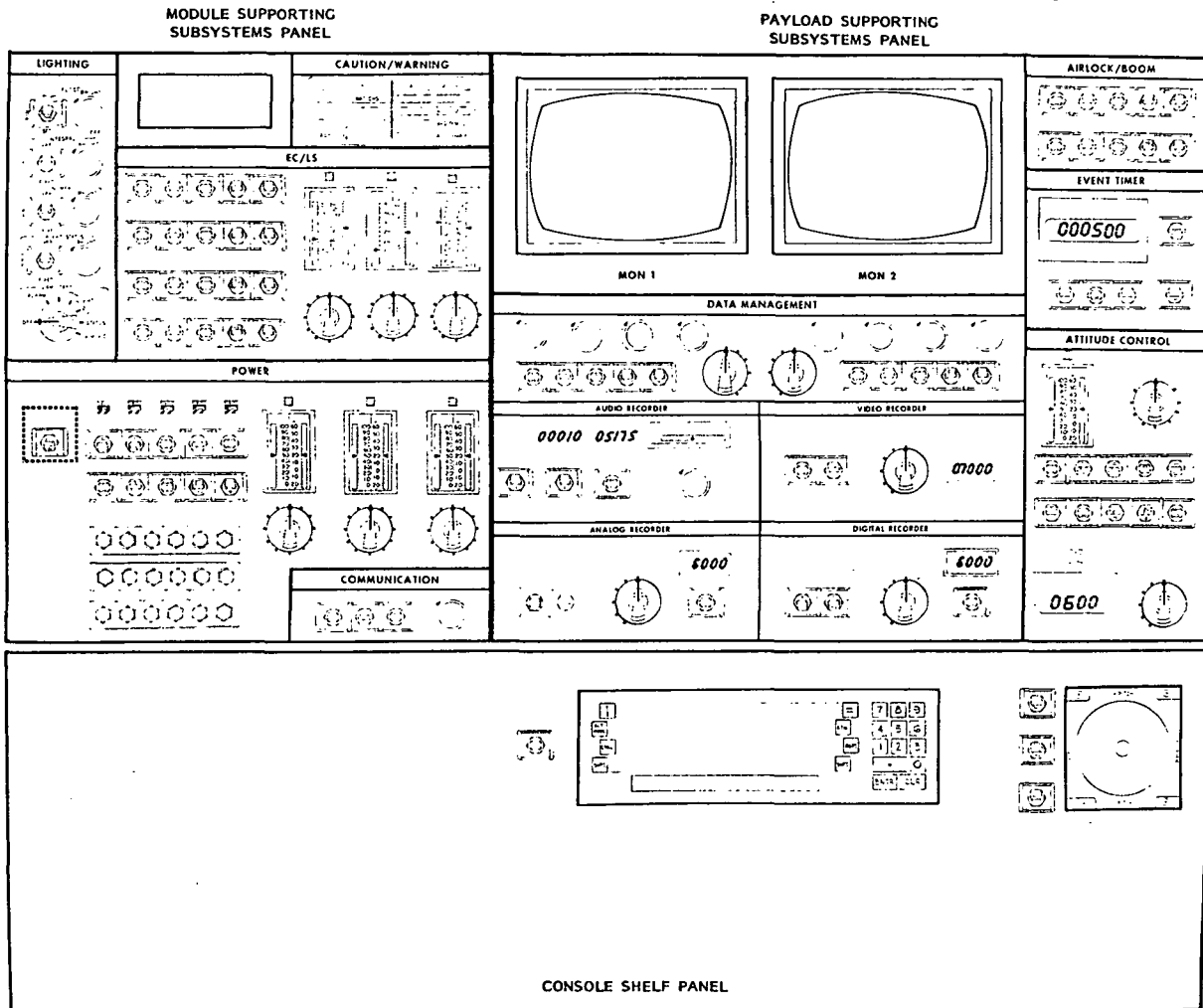


Figure 4-4: Sortie Lab Module Supporting Subsystems/Payload Supporting Subsystems Control/Display Console Panel Concept

EARTH OBSERVATIONS EXPERIMENT SUPPORT

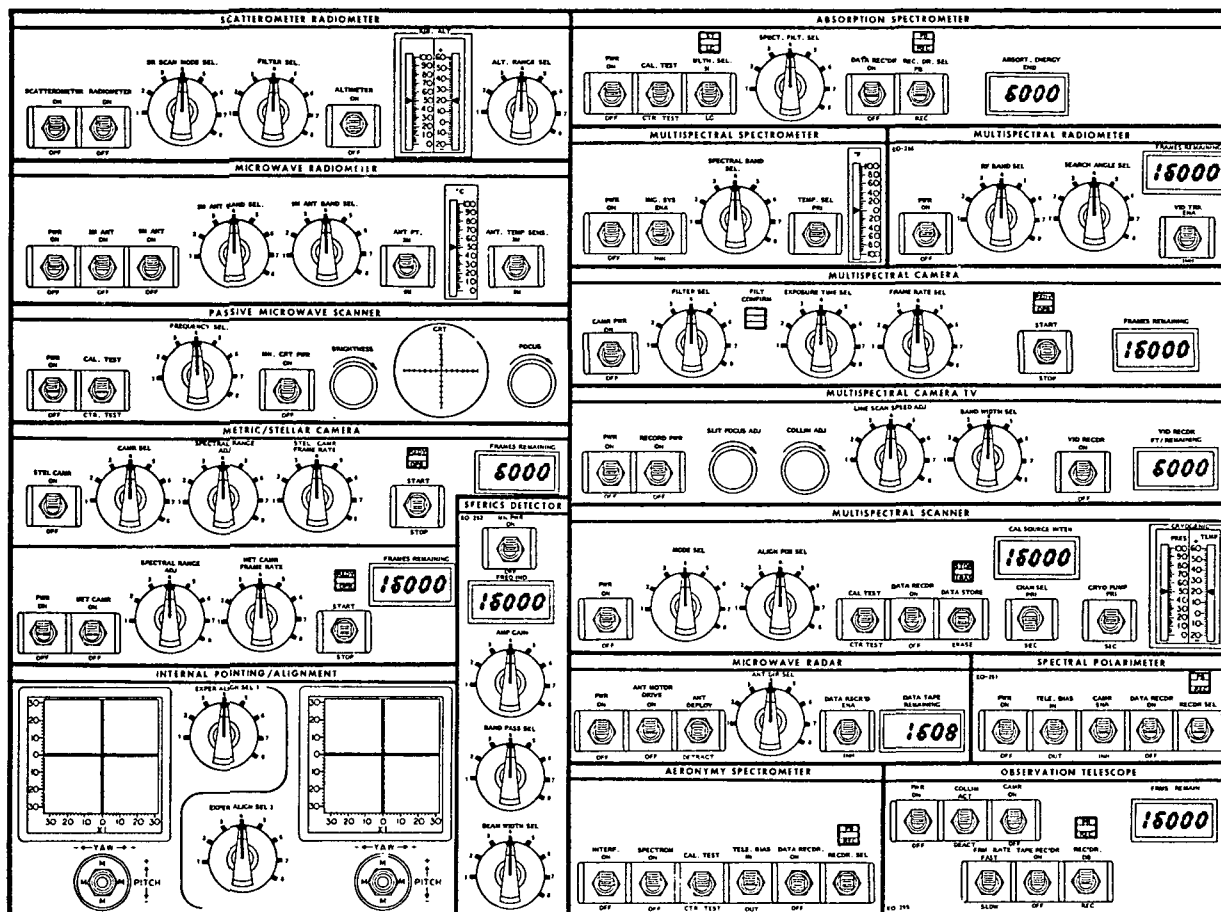


Figure 4-5: Experiment Support Control/Display Console Concept, Earth Observations

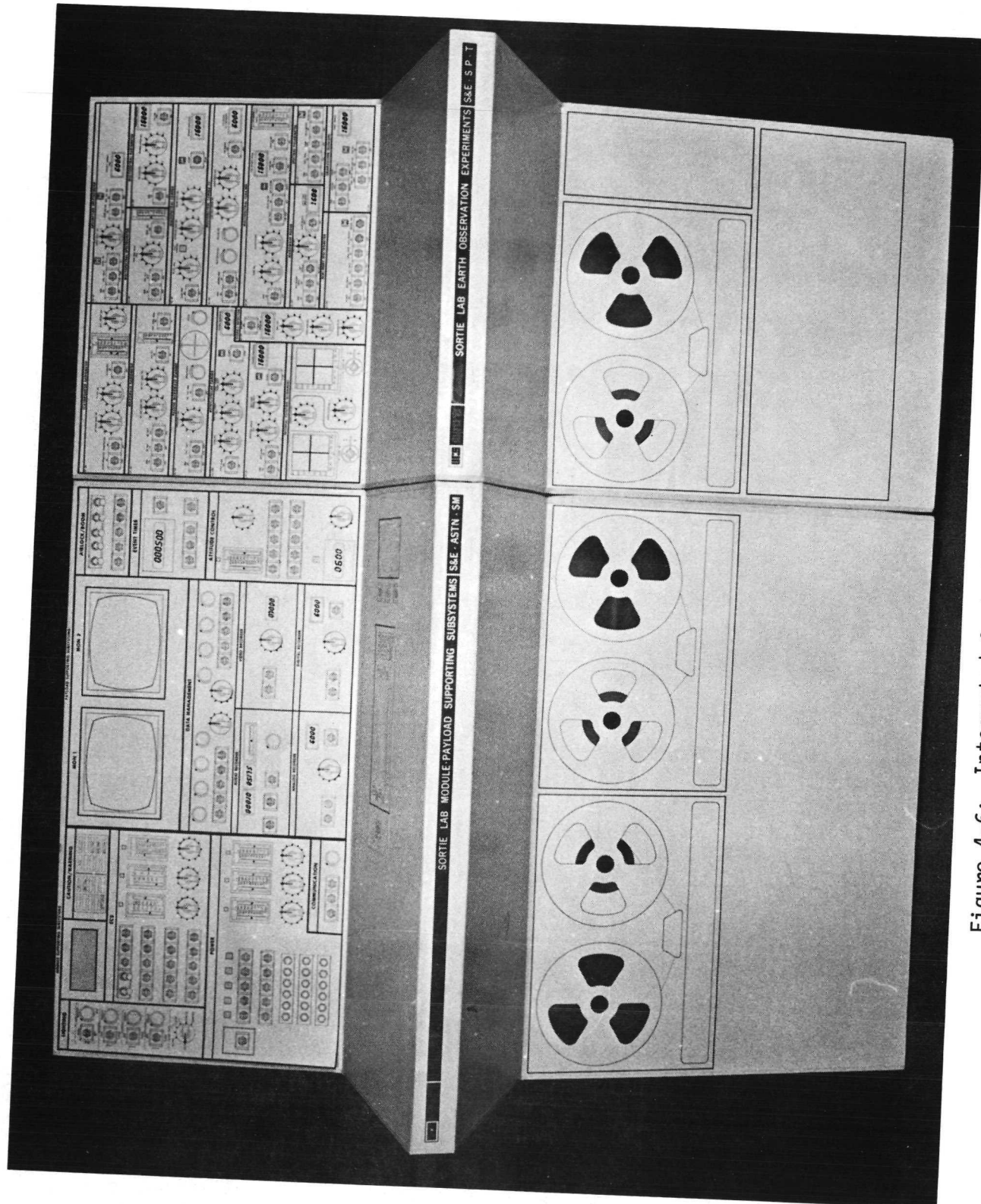


Figure 4-6: Integrated Control/Display Console
Configured for Earth Observations Missions

Manufacturing missions. These C/D requirements are itemized in Appendix G, and include all projected Materials Sciences Sortie Lab missions (and equipment) about which definitive information was obtained. Some functional requirements were satisfied by features of the module-supporting and payload-supporting console, as was the case with the EO requirements. A fairly large number of MS C/D requirements were determined to be best satisfied by having controls and display features directly on the equipment rather than on the integrated console. This generally was true when the equipment required a direct interface with the experiment, or when the equipment was estimated to be included only on an infrequent basis on Sortie Lab missions. Although it is a subjective decision at this point in time as to which items of equipment will be flown most frequently, the decision is not critical to the "concept" of an integrated MS Experiment Support C/D Console. The panel layout which resulted from those study efforts is illustrated in Figure 4-7. Integration of the MS subconsole with the Module/Payload Support Console is illustrated in Figure 4-8. Although not depicted on this layout drawing, each panel and feature thereon has been coded into the Task Dependency Reference System (Appendix D, series 2.B.06), in addition to all other C/D features whether or not they were not incorporated in the panel concept. A cross-reference between MS experiment equipment, C/D panels, and experiments, is included in Appendix G.

4.6 INTEGRATED CONSOLE CONCEPT VALIDATION

After the preliminary requirements analysis for all portions of the proposed consoles (Module Support/Payload Support/Experiment Support) were completed and preliminary panel layouts were prepared, it was appropriate to prepare full-size, soft mockups of the integrated consoles to determine concept validity. This also provided a more satisfactory visualization of the overall console configuration and the demands that this approach might place on overall Sortie Lab workspace. The finalized design concept configurations are illustrated in Figures 4-6 and 4-8. A sketch of the manner in which the integrated console might be included in Sortie Lab is shown in Figure 4-9. Inasmuch as there were no firm dimensional constraints regarding the length of the Sortie Lab module, the proportionality shown in Figure 4-9 must be regarded as an estimate.

4.7 GENERAL SUMMARY OF WORKSTATION CONCEPTS DEFINITION

The concepts presented in this section of the report provide a reasonable approach to promoting safe, efficient, and effective performance by an experiment crew in controlling, monitoring, and evaluating the conduct of Sortie Lab research while on orbit. Guidelines and constraints identifiable during the study affecting Sortie Lab definition have been observed, and are reflected in the console configurations. The actual layouts, dimensions, and/or assignment of C/D functions on the consoles must, of course, be regarded as estimates and general projections. Actual equipment to be utilized, experiments to be conducted, and combinations of payloads to be orbited are still being defined in the many studies being performed by NASA and its outside contractors. Nevertheless, it is believed that the approach followed in this study represents an important first step in defining Sortie Lab control/display requirements -- and feasible approaches to their resolution -- based on the needs of mission crews which must utilize them.

MATERIALS SCIENCES EXPERIMENT SUPPORT

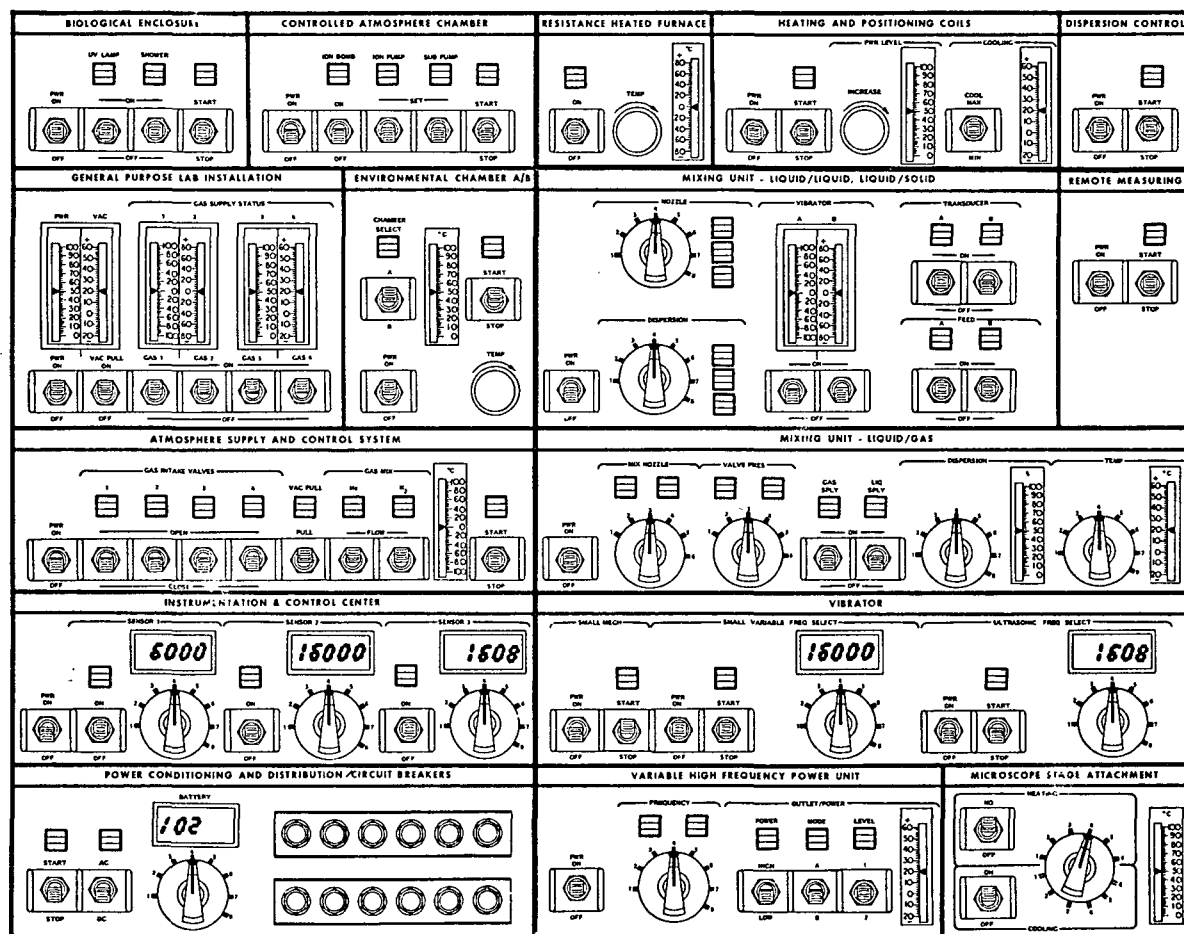


Figure 4-7: Experiment Support Control/Display Console Concept, Materials Sciences

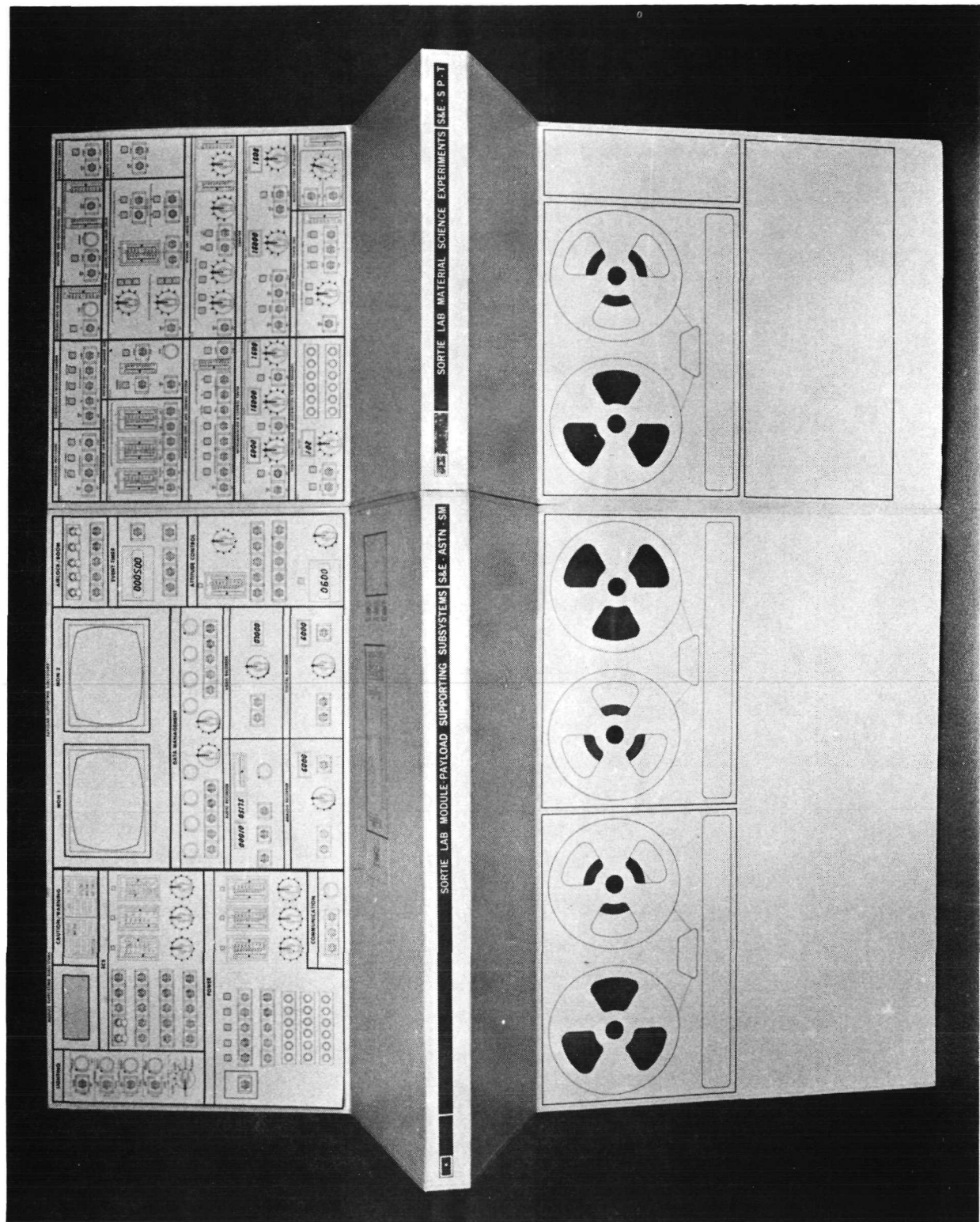


Figure 4-8: Integrated Control/Display Console Configured for Materials Sciences Missions

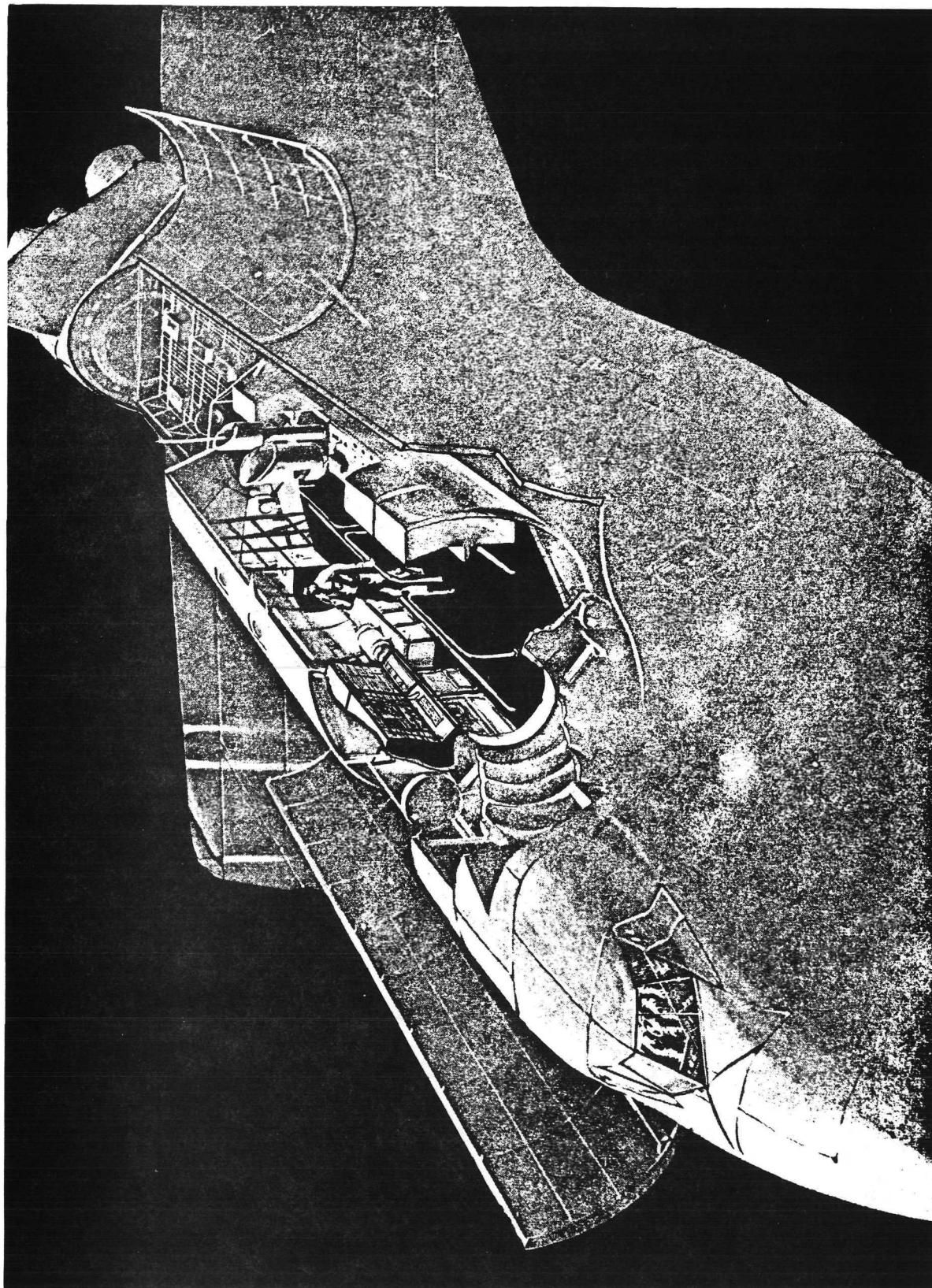


Figure 4-9: Integrated Control/Display Console in a Sortie Lab Module

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

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FINAL REPORT

SECTION 5.0

SUMMARY AND CONCLUSIONS

SECTION 5.0

SUMMARY AND CONCLUSIONS

5.1 GENERAL SUMMARY

The study presented in this report was performed by the URS/Matrix Company, Man Systems Division, under the sponsorship of NASA's Marshall Space Flight Center (Contract NAS8-28359). The three primary objectives which had been established for the program were achieved, to wit:

- (1) Definition of the scientific and technical task performance requirements and capabilities needed in support of two areas of orbital research (Materials Sciences and Earth Observations) as projected for early Sortie Lab missions;
- (2) Development of concepts for Sortie Lab experimenter workstations for these two research areas, thereby providing experiment crewmen with an efficient and effective interface with the systems and equipment which must be operated;
- (3) Revision, updating, and expansion of the task requirements and skill requirements data base originally developed under Contract NASw-2192.

5.2 SKILL REQUIREMENTS ANALYSES

The analyses of requirements for task performance capabilities needed by orbital research crewmen in support of Sortie Lab Earth Observations and Materials Sciences payloads have resulted in the identification of 820 different task-skills, twenty one (21) different Primary Occupational Skills, and five (5) different Mission Occupational Skills. The allocation of these skill assignments to the various experiments and payloads studied is shown in Table 5-1.

Although the numbers in this table are not very descriptive of the kinds of skills which may be required, they do indicate the breadth of capabilities needed at the Task-Skill level, but with a fairly narrow range of capabilities needed at the Mission Occupational Skill level. More significant, perhaps, is that the extensive commonality which exists at all skill levels, even between these two very different areas of research, indicates that mixed payloads are a very feasible option, at least from the standpoint of skills. If it can be determined that such commonality extends to other payloads and disciplines not covered by the present study, objectively derived skill requirements can legitimately take their place alongside engineering requirements as valid "drivers" in payload definition studies. With such flexibility (available in the crew resources when the requirements are identified in advance) a mixed payload may often provide a more satisfactory engineering solution than can be achieved with a single-discipline payload, especially when "suitcase" experiment add-ons are being considered.

TABLE 5-1: Allocation of Skill Requirements to Sortie Lab EO and MS Payloads



DISCIPLINE	PAYLOAD/ EXPERIMENT	TASK-SKILLS*			PRIMARY OCCUPATIONAL SKILLS*			MISSION OCCUPATIONAL SKILLS*		
		DISCIPLINE- SPECIFIC	COMMON BETWEEN DISCIPLINES	TOTAL	DISCIPLINE- SPECIFIC	COMMON BETWEEN DISCIPLINES	TOTAL	DISCIPLINE- SPECIFIC	COMMON BETWEEN DISCIPLINES	TOTAL
EARTH OBSERVATIONS	EO-3 Air & Water Pollution	145	11	156	7	7	14	1	2	3
	EO-4 Resource Recognition	137	7	144	7	6	13	1	2	3
	EO-5 Disaster Assessment	252	12	264	8	7	15	1	2	3
	TOTAL EARTH OBSERVATIONS	324	14	338	9	7	16	1	2	3
MATERIAL SCIENCES & MANUFACTURING	MS-1(1) Separation of Biologicals	112	6	118	1	7	8	1	2	3
	MS-2(1) Preparation of Glasses	156	9	165	1	7	8			
	MS-2(2) Supercooling	117	7	224	2	7	9			
	MS-2(3) Crystals Growth/Solution	152	5	157	1	7	8			
	SUBTOTAL: LEVITATION EXP. (MS-2)	276	9	285	2	7	9	2	2	4
	MS-3(1) Composite Materials	129	1	130	1	6	7			
	MS-3(2) Liquid Dispersions	155	11	166	1	6	7			
	SUBTOTAL: FURNACE EXP. (MS-3)	198	11	209	1	7	8	1	2	3
	MS-4(1) Fluid Convection	127	11	138	2	7	9			
	MS-4(2) Crystal Growth/Melts	153	11	164	1	7	8			
	SUBTOTAL: SMALL/LOW TEMP (MS-4)	215	11	226	3	7	10	1	2	3
	TOTAL MATERIALS SCIENCES	481	14	495	5	7	12	2	2	4
	GRAND TOTAL	805	14	819	14	7	21	3	2	5

* Not additive vertically

Examination of the data in Table 5-1 makes it clear that no payload, of those studied, will require more than four (4) Mission Occupational Skills, and most require only three (3). While it is again emphasized that this refers to skill complements, and not numbers of crewmen, it is also valid to conclude that the planned crew sizes of four (4) personnel for Sortie Lab are probably realistic. Much work remains to be done in timeline analysis, workloads analysis, etc., but the matching of skills to the number of available crewmen appears more feasible than if the skill complement requirements exceeded the number of crewmen available.

To keep these results in perspective, of course, it must be remembered that the skills identified herein are not all inclusive. The method used to determine these requirements should be considered a "sampling" technique which, in the composite, will identify the tasks, interfaces, and skills needed in support of a particular experiment or payload.

Notwithstanding the importance of defining specific skill requirements for specific projected missions, an equally significant outcome of this study is the demonstration that it can be done. It has been shown that the elements which dictate a need for particular personnel resources can be objectively determined, that these elements can be combined into valid predictions of requirements for specific skills, and that the sources of these skills are identifiable to specific occupational and professional descriptions.

5.3 DEVELOPMENT OF WORKSTATION CONCEPTS

A requirements analysis, conducted to enable definition of feasible and effective experiment workstations for Sortie Lab, led to the selection of an integrated Control/Display Console within the Sortie Lab Module. For a given mission and payload, the integrated console would have three functionally different segments:

- (1) Module Supporting Subsystems C/D Console
- (2) Payload Supporting Subsystems C/D Console
- (3) Experiment Support C/D Console

Two of these "subconsoles" (Module Supporting and Payload Supporting) would be permanently joined in a common console frame and would remain in the Sortie Lab at all times, including between-mission turnaround. It could, of course, be removed if major reconfigurations of the total facility were needed, or if a complete breakdown should occur, and it could be replaced by another similar console. Normal between-mission maintenance and reconfiguration (if needed) would be accomplished with the console in place in the Sortie Lab Module.

The third segment of the integrated console (Experiment Support) is specific for each type of payload, and would be interchangeable between Sortie Lab missions. This subconsole would exist in a number of variations, each designed to support a particular area of research and all compatible with the

remainder of the integrated C/D console -- both physically and functionally. Thus, the benefits of "dedicated" C/D consoles are available without their associated high costs to the total program. Likewise, between-mission down-time is minimized, and the major portion of the console is standardized, regardless of the type of research being conducted. Interconnection of the "permanent" and "interchangeable" portions of the console, as well as the interconnection of those two parts with their associated subsystems/equipment, would be accomplished through maximum utilization of plug-in cables and modules, data busses, etc., to keep changeover difficulties to a minimum.

5.4 PRINCIPAL OUTPUTS OF THE STUDY

This study, Development of Flight Experiment Work Performance and Workstation Interface Requirements, has resulted in the following principal outputs:

- Definition of specific skill and personnel resource requirements for two areas of scientific research (Earth Observations and Materials Sciences) related to Sortie Lab missions -- See Section 3.0.
- A concept for an integrated control/display console for Sortie Lab missions -- See Section 4.0.
- Conceptual designs for two experiment support subconsoles (Earth Observations and Materials Sciences) for planned Sortie Lab missions -- See Section 4.0.
- Definition of control/display functional requirements related to Sortie Lab missions -- See Appendix G.
- Definition of estimated costs for control/display components covered by the derived concepts -- See Appendix G.
- A comprehensive listing of experiment equipment and other interfaces upon which successful crew performance depends -- See Appendix D.
- A taxonomy of crew functions related to on-orbit research and applications, with complete definitions -- See Appendix B.
- A documented task-skill analysis of eleven (11) experiment areas in two disciplines defining tasks to be performed, interfaces, and skill requirements -- See Appendix H.

5.5 CONCLUSIONS AND RECOMMENDATIONS

This study represents an initial effort toward providing quantified projections of the scientific and technical human resources that will be required for a sizable portion of future NASA programs, permitting such factors to become "design drivers". This is definitely required for future programs, especially in view of severely constrained program development budgets, in order to take maximum advantage of available skills and knowledge; to reduce long lead time, mission-specific training; to eliminate equipment redesign which would otherwise be required to achieve man-equipment interface

compatibility, and to preclude most of the operational errors which occur when design is "frozen" without reflecting the capabilities of the personnel who are likely to be operating the equipment.

As a result of this study, it is concluded that:

- a. It is feasible to identify skills required of crew members early in the definition phase of development programs. It is neither necessary nor appropriate to wait for complete definition of equipment, facilities, or objectives prior to initiating a skill requirements analysis.
- b. Assessment of skill requirements can and must be based on an objective evaluation of the activities and tasks which personnel may be required to perform. The assessment should be at as detailed a level as is possible considering the status of program definition. Subjective evaluations which result in instant "skill requirement" specification should be avoided. Such an approach is invalid, and it can be misleading to mission planners. When subjective evaluations are used to develop prime crew skill complements, an infinitely large and varied population of skilled personnel must be available, at the experiment site, to compensate for the planning oversights which inevitably occur.
- c. Determination of skill requirements at the elemental level, i.e., Task-Skills, will permit crew complements to be partially structured as a direct output of timeline analysis. This is true since each element in a detailed timeline analysis will have one or more identified task-skills already associated with it. Appropriate use of automatic data processing and sorting methods will provide immediate identification of conflicts between requirements for and availability of specified skills.
- d. Workstation planning and preliminary design can be accomplished using preliminary human performance requirements and capabilities data as design drivers, as is evidenced by the workstation concepts documented in this report.
- e. A method is available for utilization of skill requirements information as an aid to experiment and mission planners in making decisions regarding configurations, policy, procedures, and objectives. It is hoped that this method will be widely utilized in concert with other valid decision criteria, since man's flexibility as a system element, while broad, is not limitless.

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**APPENDIX A
BIBLIOGRAPHY OF REFERENCE PUBLICATIONS**



APPENDIX A

BIBLIOGRAPHY OF REFERENCE PUBLICATIONS

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**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

APPENDIX B

DEFINITIONS OF FLIGHT EXPERIMENT CREW FUNCTIONS

AND

CREW FUNCTIONS

APPENDIX B

DEFINITIONS OF FLIGHT EXPERIMENT FUNCTIONS AND CREW FUNCTIONS

MAJOR FUNCTIONS[@]

SHUTTLE FLIGHT (F) FUNCTIONS: These functions are basically independent of the nature of the R&A mission, except as they affect orbit selection, etc. All operating functions are the responsibility of the flight crew. The experiment crew members, if present, will be impacted in their roles as passengers and will have habitability tasks to perform.

RESEARCH AND APPLICATION (R) FUNCTIONS: These are functions directly related to the R&A mission, and they will show wide variation depending on the FPE or experiments being flown. All functions are the responsibility of the Experiment Module (EM) crew, or, in certain instances, the flight crew*. The functions have in common the performance of experiments in orbit and the activities which must take place preceding and subsequent to that performance.

SERVICING (S) FUNCTIONS: These functions are related to the R&A missions, and may be the responsibility of the EM crew or the flight crew, depending on type of mission. These functions will be included in all missions except Mission Mode A, Type 2. The servicing functions deal with maintenance, repair, and replacement of experiment equipment.

HABITABILITY (H) FUNCTIONS: These functions are basically independent of the nature of the R&A mission, and are superimposed over all other functions to ensure the safety, comfort, and survival of the crew members. All crew members will be involved in these functions.

REMOTE CONTROL (D) FUNCTIONS: These functions are the responsibility of the ground control team or a Space Station team, and deal with automatic or remotely controlled conduct of experiments. It is possible that an Orbiter flight crew may act in the capacity of remotely controlling the experiments in Mission Mode A, Type 2, but no information is presently available pertaining to this possibility.

Summary: Basic function descriptions for Major Functions R and S follow, and the study is based on further breakdown and definition of those functions.

[@]See Reference 68.

*On servicing missions or automatic missions, there may be no separate EM crew, in which case the flight crew has this responsibility.

BASIC FUNCTIONS

01 DEPLOY EXPERIMENT MODULE (EM)

This function may be the responsibility of the EM crew*, the flight crew, or both together. Deploying the module will be primarily automatic and will be initiated from the orbiter command area. Crewmen will monitor, through use of visual observations (instruments, TV, etc.), the progress of the deployment. In most cases, this will consist of opening the payload hatch doors, extending the RAM outside the orbiter envelope, and bringing it to the appropriate attitude for either experiment conduct or detachment. In some cases, the EM may stay within the payload bay, so only the opening of the payload hatch doors is involved.

Manual override of the automatically controlled process will be possible in case problems of deployment threaten the integrity of the spacecraft.

Major subfunctions are:

- Secure spacecraft (orbiter, etc.)
- Self-test deployment systems
- Open payload hatch
- Initiate deployment sequence
- Monitor deployment progress
- Inhibit deployment sequence (in case of fault)

Some EM-specific variations may exist, but crew tasks should be very similar for all missions. The shirtsleeve environment is envisioned for all currently anticipated missions.

02 STOW EXPERIMENT MODULE (EM)

This function may be the responsibility of the EM crew, the flight crew, or both, depending on the type of mission. In any case, it will be primarily automatic. All constraints, conditions, and subfunctions should be as in 01 (DEPLOY EM), but reversed.

Normally, this function will be performed only when the mission is completed and the EM/Orbiter combination is to be returned to earth. In addition, it may be required when the mission cannot be completed due to equipment malfunction, personnel illness, etc., and the deficiency cannot be corrected in orbit.

03 TRANSFER CREW TO EM/SSM

This function is the responsibility of the EM crew*, with the flight crew monitoring progress and providing some general support. The transfer will be

*On servicing missions or automatic missions, there may be no separate EM crew, in which case the flight crew has this responsibility.

manual in all envisioned missions and will be comprised of the EM crewmen opening the airlock hatch to the EM or SSM, passing themselves and their belongings through the passageway into the module. Some configurations may require a pressurization sequence prior to entry. Others may require the translation to be made in full pressure suits (e.g., if EM is not habitable).

On Shuttle-sortie missions, there should be very little cargo transfer involved, limited primarily to the personal belongings which the EM crew members carry with them in the Orbiter. (All experiment equipment will normally be stowed in the EM or SSM before launch.)

On servicing missions, cargo transfer requirements will be much lighter, since fresh logistics supplies, spare parts, tools, and perhaps new/additional instruments will be transferred.

Major subfunctions:

- Pressurize EM (if required)
- Self-test EM/SSM habitability
- Open airlock(s)
- Transport self and cargo thru passageway
- Secure airlock(s)

04 EXPERIMENT SETUP

This function is the responsibility of the EM crew. Depending on the nature of the FPE and the extent to which experiment equipment and instrumentation has been secured/stowed for launch and ascent, this function may be either very simple or very complex. The simplest mission will be that where all equipment is prelocated in its operating position or is deployed automatically. A self-test and calibration sequence will probably be initiated (this could be done from the orbiter or ground, not requiring the EM crew in the module), and if everything is in order, no further EM crew tasks exist in this function.

At the other extreme, where man is a direct participant in the experiment (either as controller, subject, or both), the EM crew will determine which experiments are to be conducted, select appropriate equipment, assemble the experiment equipment arrays, deploy them as appropriate, and perform test and checkout for proper operation. The process may be repeated many times, depending on duration of the flight, experiment results, and other similar factors.

The environment in which this function is performed may likewise show wide variation. In most cases, this should be a shirtsleeve environment; in some cases it will be IVA, requiring full pressure suits; in a few cases (e.g., where instruments must be mounted on the exterior surface of the EM), EVA may be required. Details regarding IVA and EVA requirements are quite limited, but these modes must be anticipated.

Major subfunctions are:

- Determine experiments to be run (A/R)
- Select experiment equipment (A/R)
- Assemble experiment equipment
- Deploy experiment equipment
- Test, check out, calibrate, align, etc., experiment equipment
- Initiate experiments

05 EXPERIMENT SHUTDOWN

This function will normally be the responsibility of the EM crew. Exceptions would occur when the experiments are to be totally automated, when controlled remotely from ground or Space Station, or when the mission is to be of the servicing type with this function being designated to the orbiter flight crew.

The function will be performed at the completion of a sequence of experiments, at the completion of the orbital mission, or for purposes of performing scheduled or unscheduled maintenance. The nature of the function is typically the reverse of 04 (EXPERIMENT SETUP), although there should be little requirement for judgmental decisions. In addition, depending on the reason for shutdown, the function may consist only of temporary deactuation or may require complete shutdown, packaging, and stowage of equipment and data. The skills required will be largely mechanical skills.

Major subfunctions are:

- Determine experiments to be shut down (A/R)
- Deactivate operating equipment
- Disassemble equipment arrays
- Retrieve data held by equipment
- Package equipment for stowing
- Stow equipment

06 EXPERIMENT CONDUCT

This function is the responsibility of the EM crew, except in those cases where experiment conduct is controlled automatically or remotely from ground or Space Station (see Function D).

The nature of the function to the crew will vary widely, from simple monitoring requirements (where actual performance is almost completely automatic), to step-by-step participation by both crew and instruments, to those experiments where crew members are both experimenters and subjects. Crew skills must reflect the nature of the equipment being utilized, the subject of the experimentation, and the type of data being collected.

Major subfunctions are:

- Control experiment equipment
- Observe object/subject of experiment

- Monitor experiment progress
- Evaluate experiment results

07 DETACH EXPERIMENT MODULE (EM)

This function will be the responsibility of the EM crew, the flight crew, or both. Only two types of missions requiring this function are foreseen: (1) after initial setup of a long-duration, automated, free-flying RAM[†]; (2) after completion of periodic servicing in orbit of the automated, free-flying RAM. A third type of mission is also possible, e.g., when, because of a malfunction, the EM cannot be properly stowed in the Orbiter for return to earth. In such a case, the EM crew (if occupying the EM) would return to the Orbiter, and the EM would be left in orbit.

The function will consist primarily of assuring that all appropriate spacecraft and RAM systems are secure and operating as intended, and then performing undocking. Actual undocking will probably be mechanical unlatching of the retaining mechanisms, followed either by passive separation (drifting apart) of the Orbiter and RAM, or active separation wherein either the RAM or Orbiter uses propulsive power to achieve separation.

Major subfunctions are:

- Secure Orbiter-RAM interfaces
- Initiate undocking

All remaining subfunctions are expected to be totally flight-crew functions, although the EM crew (if present) may provide some general support. It is possible that EM crew members may remotely "fly" the RAM away from the Orbiter, if the RAM has an active propulsion/separation system.

See also 08 (RETRIEVE EM)

08 RETRIEVE EXPERIMENT MODULE (EM)

This function will, in all likelihood, be primarily the responsibility of the flight crew, although the EM crew may provide some support and, in the case of a self-propelled, free-flying RAM, may actually fly the RAM to the Orbiter by means of remote control, in order to initiate docking.

Major subfunctions are as in 07 (DETACH EM), but in reverse. Constraints and conditions are the same.

09 PERFORM SCHEDULED MAINTENANCE

This function will be the responsibility of the EM crew or the flight crew, depending on the specific mission being serviced. This function may

[†] Research and Applications Module

occur as part of periodic servicing of an automated, free flyer, or it may be part of the schedule of events to be performed during a manned R&A mission.

The functions will include items such as cleaning, lubricating, realignment, recalibration, testing, and inspection of experiment equipment, as well as scheduled replacement of equipment components and modules. In most cases, the functions will be performed in a shirtsleeve environment, although it is possible that some elements may require IVA or EVA.

Crew skills required are envisioned as being primarily technical, rather than scientific, and in many cases no special skills will be required.

10 PERFORM UNSCHEDULED MAINTENANCE

This function is very similar to 09, with the additional functional requirements of trouble-shooting, malfunction analysis, and equipment repair. Unscheduled maintenance may be required at any time, as indicated by the identification of a malfunction, fault, or abnormal operation of equipment. Functional performance may be by either the EM crew or the flight crew, or by both, depending on the problem and the type of mission.

The environment for performance of this function may be shirtsleeve, IVA or EVA. Crew Skill requirements should be similar to those in Function 09.

APPENDIX B

CREW FUNCTIONS*

01. STATUS MONITORING - Maintain cognizance of progress of events and operations by reviewing status indicators. Indicators may be visual, aural, etc. MONITORING requires use of intervening equipment between subject (object), system and monitor. It is either automatic or semiautomatic, never manual. This function is system or equipment oriented, and displays require little or no interpretation, being primarily go/ no go, or "within pre-established limits", or direct readouts of quantitative data, e.g., pressure, temperature, elapsed time, etc.

02. OBSERVATION - Attentiveness to status, or changes in status, of the object or subject of experimentation. OBSERVATION may be indirect through the use of supporting equipment and instruments. This function is experiment oriented, and the observed parameters may be either quantitative or qualitative in nature. Interpretation of the observed parameters will generally be required in light of the nature of the experiment and the object or subject being observed.

03. INSPECTION - Performance of critical visual examination of operating equipment units for a specific condition, in order to determine whether the equipment should continue in operation or use, or whether repair or replacement is required. Also included will be the examination of parts and materials for evidence of wear, deterioration, or defects. This function is equipment and facility oriented and is primarily related to maintenance activities.

04. PATTERN RECOGNITION - Classification of phenomena or events based on current data. The classification rules will be either deterministic or probabilistic but will be unknown prior to recognition. This function is experiment oriented, and the OBSERVATION function is generally a prerequisite. The function may be thought of as the integration of observations, ambient conditions, and other factors to form a relevant conclusion.

05. COMMUNICATION - Transmittal of pertinent information regarding any aspect of the experiment or equipment to other locations. COMMUNICATION may be direct (through voice, touch, or signal) or may be indirect through the use of electronic equipment.

06. DATA PROCESSING - Accepting data, information or experiment related material in one form, and, through mental, manual, or machine manipulations, transforming it into another form. This function is common to all aspects of Experiment Module operation and maintenance, although emphasis will be given to areas related to experiments. Examples may be tasks such as film developing, transforming CRT-displayed data to hard-copy, making straight forward arithmetic calculations, and entering data into the computer to be run against a pre-established program.

* Utilization of Crew Functions is explained in the text, paragraph 2.2.3.

07. FAULT ISOLATION - Determination of the type, cause and location of a failure or malfunction which has occurred in experiment equipment or in experiment support equipment. In many instances, the location of the failed item may be provided by the status monitoring instrumentation or by Built-In Test Equipment (BITE). In other cases, some level of equipment disassembly may be required to locate the malfunctioning part to the lowest replaceable module.

08./09. CALIBRATION/ALIGNMENT - CALIBRATION is the determination of accuracy, deviation from norm, or variation, by special measurement or by comparison with a standard. ALIGNMENT is the adjustment of controls (in some cases direct movement of equipment units) so as to match visual indicators such as pointers, wave forms, and lines of sight, or to alter aural signals until coincidence is achieved. These two functions are very similar, and are therefore grouped together. In CALIBRATION, the objective is to determine the amount of difference; in ALIGNMENT, the objective is to eliminate the difference even though the amount of the difference may be unknown. In some cases, the function will be largely automatic, so the crewman's task is primarily one of initiating the sequence when it is needed and monitoring its progress. In other cases, the function may be completely automatic and will require no crew attention at all.

10. CONTROL - Active provision of inputs to a system, equipment, or operation, to insure that it remains within the limits selected by the controller and/or follows a definite sequence of operations determined by the controller. CONTROL may be continuous, sequential, or even intermittent, and it requires that inputs be made to the system or equipment while it is operating or to the operation while it is in progress. The primary information on which CONTROL is based is feedback from the system, equipment, or operation to the controller, and the relationship of that feedback information to what is desired by the controller.

11./12. EVALUATION/ANALYSIS - Careful examination and interpretation of test or experiment results, or of the characteristics of the subject/object of a test or experiment, to determine the conditions represented by those results and/or characteristics. EVALUATION generally involves a purely mental process wherein the results of characteristics are weighed against the evaluator's prior knowledge of what is expected. ANALYSIS generally goes a step further and may require that data be transformed, calculations be made, or results or characteristics be quantitatively and/or qualitatively matched against some pre-established standard.

13. DECISION MAKING - Selection of a course of action based on a probabilistic estimate on which of several courses is most likely to result in success. A simple "decision" to proceed as planned involves DECISION MAKING only if new information has created some reasonable alternative courses of action. One or more other functions, such as STATUS MONITORING, OBSERVATION, PATTERN RECOGNITION, and EVALUATION/ANALYSIS, will almost always precede this function.

14. TEST AND CHECKOUT - Performance of operational readiness testing on components, equipment, and systems to determine that they are operating, or will operate, within acceptable limits. This function will almost always include the use of some specialized instrumentation to enable the crewman to more readily ascertain the state of readiness of the equipment. The process may, in fact, be almost totally automated, requiring only that the TEST AND CHECKOUT sequence be initiated by the crewman. This function is very similar to FAULT ISOLATION except that no failure is known to have occurred when it is initiated. The same testing equipment/instrumentation will generally be used for both functions.

15./16. ACTUATION/DEACTUATION - Initiating/stopping a process or operation by the fairly basic means of turning power on/off, pushing start/stop buttons, etc. Only when the process is time-critical does the function become other than routine. In many cases, it will be preceded by functions such as PATTERN RECOGNITION, DECISION MAKING, etc. In other cases, it will be accomplished in accordance with a pre-established program of events. This function is basically a motor task.

17./18. STOW/UNSTOW - STOW is the process of packaging an item of equipment, test sample, etc., placing it in a previously designated storage location, and securing it against normal, expected outside influences, as well as preventing the item from interfering with other activities. UNSTOW is, of course, the opposite of STOW. The UNSTOW function will generally occur during experiment setup; the STOW function will generally occur following experiment conduct, during experiment shutdown. The function may be interrupted by other functions such as ASSEMBLY/DISASSEMBLY, TRANSLOCATION, and INSPECTION.

19. CLEAN/DECONTAMINATE - Removal of dirt, grime, dust, or other contaminants (including biological). This is a very broad function which may range from simply wiping off an object (e.g., optics) with a soft, clean cloth, to subjecting experiment equipment to an ultrasonic "bath". The function may follow the INSPECTION function which determines that cleaning is necessary or it may be a preprogrammed event, and it may or may not be followed by INSPECTION. The complexity of the function will vary with the nature of the item being cleaned, the contaminant being removed, the method of cleaning, and the conditions under which it is being performed (e.g., EVA).

20./21. ASSEMBLY/DISASSEMBLY - ASSEMBLY is the performance of the various manual operations of fitting and securing together two or more equipment items in order to complete a subunitary or unitary assembly. DISASSEMBLY is the reverse of ASSEMBLY. The function may be performed as a maintenance activity (during repair, replacement, cleaning, etc.) or as an experiment-oriented activity (during experiment set up or shutdown). The function is primarily motor, but will in many cases require detailed knowledge of the equipment to be assembled or disassembled.

22. TRANSLOCATION - Movement of a mass (e.g., cargo, film magazine, equipment unit, or test sample) from one point to another point. Complexity is determined by factors such as origin, destination, available routes, size, mass and translocation assistance. The function may be semiautomatic or manual, and it may be

within a given environment or between different types of environments. When the function is manual, it may or may not include crewman LOCOMOTION.

23./24. DEPLOYMENT/RETRIEVAL - DEPLOYMENT is positioning an item of experiment equipment in its operational location and configuration and securing it in that position and configuration. RETRIEVAL is the reverse process. If movement of the item of equipment from point to point is required, TRANSLOCATION is a necessary, integral function. DEPLOYMENT/RETRIEVAL may be manual, semi-automatic or automatic.

25. LOCOMOTION - Movement of the body from one point to another point at some finite distance from the first. LOCOMOTION may be completed unaided (e.g., walking, floating, jumping, "swimming") or partially aided (e.g., self-propulsion devices, carriers, moving treadways, etc.). LOCOMOTION refers to the movement of the crewman; it does not refer to an item of equipment, a test specimen, or cargo. LOCOMOTION may be involved in TRANSLOCATION of such an item, however.

26./27. REMOVAL/REPLACEMENT - REMOVAL is the performance of the various manual operations necessary to take an equipment item, test specimen, or module out of the next larger assembly or system. REPLACEMENT is the opposite of REMOVAL, and further includes initial "placement" or installation of the item in the larger assembly. A distinction must be made between REMOVAL/REPLACEMENT and ASSEMBLY/DISASSEMBLY. In REMOVAL/REPLACEMENT, the major assembly remains basically intact, although it may or may not be operable with the equipment unit removed. In ASSEMBLY/DISASSEMBLY, the major assembly or system does not remain intact, and, when disassembled, it is always inoperable.

28. REPAIR - The act of restoring damaged, worn-out, or malfunctioning equipment to a serviceable, usable, or operable condition. REPAIR may include both ASSEMBLY/DISASSEMBLY and REMOVAL/REPLACEMENT functions, and it will usually require the use of special tools, equipment and materials for successful accomplishment of the function. The FAULT ISOLATION function will be a frequent prerequisite.

29. UNKNOWN - The nature of the crew functions cannot be determined due to insufficient information and/or detail.

30. SUBJECT FOR EXPERIMENT - A function in which one or more crewmen are evaluated as to their performance, response to stimuli, physiological state, etc. They represent "test specimens", experiment variables, etc., and, in such capacity, they may be called upon to perform any of the other crew functions which have been identified. In this analysis, crew functions performed as a SUBJECT FOR EXPERIMENT will always be shown in addition to the crew functions performed as experimenters, experiment controllers, etc.

31. OCCUPY - This is a specialized crew function wherein the crewman must be located in or on a particular item of equipment or a specific location with respect to the equipment. OCCUPY includes sit, stand, lie, etc. It is a passive function in that no particular activity is expected.

32. WEAR - This is a specialized crew function, similar to number 31, where the crewman is clothed in a particular kind of garment, or is bearing certain items of equipment that are strapped or otherwise fastened to his body (e.g., helmets, harnesses, etc.). Other crew functions are generally performed at the same time.

33. RECEIVE - A specialized crew function, wherein the crewman is the recipient of some experiment-related substance or material. As used in this study, the function includes ingestion of foodstuff or medication, receiving hypodermic injections, etc.

34. DONATE - A specialized crew function, the reverse of RECEIVE. The crewman gives up material for the purpose of the experiment. Such activities include the taking of blood, urine and fecal material sampling, and provision of saliva for tests.

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

APPENDIX C

**TASK-SKILL/OCCUPATIONAL SKILL
CROSS-REFERENCE BY PAYLOAD**

APPENDIX C

TASK-SKILL AND OCCUPATIONAL SKILL

CROSS-REFERENCE BY PAYLOAD

This appendix comprises a series of Tables showing the assigned task-skills, Primary Occupational Skills, and Mission Occupational Skills for each payload studied, individually. It is intended primarily for users of the information who are working at the payload level, and who are not concerned with combined payloads or mixed payloads.

The tables included, and the relationship to the composite tables in Section 3.0 of the text, are as follows:

P/L #	EXP. #	TITLE	REFERENCE TABLE #		
			INDIVIDUAL PAYLOAD	PAYLOADS IN DISCIPLINE	ALL EO & MS
EO-3	(1)	Air and Water Pollution	C-1	3-2	3-6
EO-4		Resource Recognition	C-2		
EO-5		Disaster Assessment	C-3		
MS-1		Biological Experiments Separation of Biologicals	C-4	3-4	
MS-2		Levitation Experiments	C-5		
		(1) Preparation of Glasses			
		(2) Supercooling/ Homogeneous Nuc.			
(3) Crystal Growth from Solutions					
MS-3		Furnace Experiments	C-6		
		(1) Composite Materials (2) Liquid Dispersions			
MS-4	Small/Low Temperature Experiments	C-7			
	(1) Fluid Convection (2) Crystal Growth from Solutions				



TABLE C-1: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-3
(Air and Water Pollution).

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS											
CODE	TITLE	EO-3	Air	Water	Pollution	CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector
0004	Telescope Optics Cleaner	△				000.000											
0036	Spectrometer Control Actuator	△				003.181											
0038	Spectrometer Fault Identifier	△				003.187											
0040	Spectrometer Tester	△				003.187											
0046	Film Cartridge Installer	△				003.281											
0072	Spectrometer Calibrator	△				007.081											
0095	Spectrometer Optics Cleaner	△				024.081											
0096	TV Camera Optics Cleaner	△				025.088											
0097	Camera Lens (Optics) Cleaner	△				025.288											
0109	Spectrometer Module Remover	△				710.884											
0110	Spectrometer Module Installer	△				714.684											
0111	TV Camera Module Remover	△				722.281											
0112	TV Camera Module Installer	△				828.281											
0158	Camera Module Remover	△				xxx.xxx											
0160	Camera Module Installer	△															
0187	Telescope Module Remover	△															
0188	Telescope Module Installer	△															
0204	Camera Mode Monitor	△															
0206	Radio Communicator	△															
0209	Scanner Mode Monitor	△															
0212	TV Camera Mode Monitor	△															
0245	Camera Control Actuator	△															
0265	Telescope Mode Selector	△															
0267	Spectrometer Mode Selector	△															
0268	TV Mode Selector	△															
0271	Camera Mode Selector	△															
0294	Camera Inspector	△															
0297	Telescope Aligner	△															
0320	Telescope Control Deactuator	△															
0328	Film Processor *	△															
0335	Camera Controller **	△															
0336	Spectrometer Controller **	△															
0337	Telescope Controller **	△															
0345	TV System Module Remover	△															
0346	TV System Module Installer	△															
0409	Spectrometer Control Deactuator	△															
0516	Meteorological Condition Observer	△															
0519	Computer Module Remover	△															
0520	Computer Module Installer	△															
0637	Radiometer Module Installer	△															
0638	Radiometer Module Remover	△															
0644	Radiometer Mode Monitor	△															
0653	Polarimeter Mode Monitor	△															
0672	TV Camera Control Deactuator	△															
0673	Radiometer Control Deactuator	△															
0689	TV Camera Fault Identifier	△															
0691	Radiometer Fault Identifier	△															
0692	Radiometer Repairer	△															
0779	Spectrometer Repairer	△															
0787	Spectrometer Mode Monitor	△															
0828	Scanner Inspector	△															
0829	Radiometer Inspector	△															
0831	Polarimeter Inspector	△															
0833	Spectrometer Inspector	△															
0842	Scanner Control Actuator	△															

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [△] = Task-Skill Required by Payload/Experiment.

*No Occupational Skill Assigned; see text, paragraph 3.2.1

**No Mission Occupational Skill Assigned; see text and Figure 3-2

Table C-1, p. 1 of 3



TABLE C-1: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-3
(Air and Water Pollution).

(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS									
CODE	TITLE	EO-3	Air	Water	Pollution		CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Geophysicist	Meteorologist	Weather Observer
0843	Radiometer Control Actuator						000.000									
0844	Polarimeter Control Actuator						003.181									
0846	Telescope Control Actuator						003.187									
0848	Camera Control Deactuator						003.187									
0849	Scanner Control Deactuator						003.281									
0852	Film Stower						007.081									
0869	Scanner Data Quality Monitor						024.081									
0870	Radiometer Data Quality Monitor						025.088									
0872	Spectrometer Data Quality Monitor						025.288									
0873	Polarimeter Data Quality Monitor						710.824									
0874	Telescope Operation Evaluator						714.684									
0875	Camera Operation Evaluator						722.281									
0876	Scanner Operation Evaluator						828.281									
0877	Radiometer Operation Evaluator						xxx.xxx									
0879	Spectrometer Operation Evaluator															
0880	Polarimeter Operation Evaluator															
0884	Scanner Optics Cleaner															
0885	Telescope Fault Identifier															
0886	Camera Fault Identifier															
0887	Scanner Fault Identifier															
0889	Polarimeter Fault Identifier															
0891	Optical Equipment Fault Identifier															
0895	Telescope Presentation Observer															
0896	TV Presentation Observer															
0897	Scanner Presentation Observer															
0898	Radiometer Presentation Observer															
0904	Scanner Module Remover															
0905	Scanner Module Installer															
0908	Polarimeter Module Remover															
0909	Polarimeter Module Installer															
0914	Polarimeter Presentation Observer															
0915	Spectrometer Presentation Observer															
0916	Scanner Mode Selector															
0917	Radiometer Mode Selector															
0918	Polarimeter Mode Selector															
0919	Polarimeter Control Deactuator															
0922	TV Data Quality Monitor															
0923	TV Camera Operation Evaluator															
0924	Radiometer Optics Cleaner															
0925	Polarimeter Optics Cleaner															
0926	Earth Survey C/D Equipment Module Remover															
0927	Earth Survey C/D Equipment Module Installer															
0928	Earth Survey C/D Equipment Fault Identifier															
0942	Telescope Mode Monitor															
0943	Telescope Mode Recorder															
1193	Telescope Repairer															
1194	TV System Repairer															
1195	Camera Repairer															
1344	Camera Operation Monitor															
1448	Camera Tester															
1549	TV System Control Actuator															
2045	TV Camera Mode Recorder															
2046	Scanner Mode Recorder															
2047	Radiometer Mode Recorder															
2048	Polarimeter Mode Recorder															

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [V] = Task-Skill Required by Payload/Experiment.



TABLE C-1: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-3
(Air and Water Pollution).

(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS									
CODE	TITLE	EO-3	Air	Water	Pollution		CODE	General Technical Skill	Electrical Technician	Radio Engineer	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Geophysicist	Meteorologist	Weather Observer
2049	Spectrometer Mode Recorder						000.000									
2050	Camera Status Monitor						003.181									
2051	Time Elapsed Observer**						003.187									
2053	Atmospheric Pollution Data Observer						003.187									
2054	Water Pollution Data Observer						003.281									
2055	Water Pollution Data Evaluator						007.081									
2056	Atmospheric Pollution Data Evaluator						024.081									
2057	Meteorological Conditions Evaluator						025.088									
2058	Mission Events Evaluator**						025.288									
2059	TV System Inspector						710.884									
2060	TV System Tester						714.684									
2061	Scanner Tester						722.281									
2062	Polarimeter Tester						828.281									
2063	Polarimeter Aligner						xxx.xxx									
2064	TV System Fault Identifier															
2065	Earth Survey C/D Equipment Repairer															
2066	Scanner Repairer															
2067	Polarimeter Repairer															
2068	TV System Control Deactuator															
2076	TV Data Classifier															
2077	Scanner Data Classifier															
2078	Radiometer Data Classifier															
2079	Polarimeter Data Classifier															
2080	Spectrometer Data Classifier															
2081	Polarimeter Controller**															
2082	TV Data Analyzer															
2083	Scanner Data Analyzer															
2084	Radiometer Data Analyzer															
2085	Polarimeter Data Analyzer															
2086	Spectrometer Data Analyzer															
2087	Telescope Data Analyzer															
2088	Scanner Adequacy Determiner															
2089	TV Camera Adequacy Determiner															
2090	Radiometer Adequacy Determiner															
2091	Polarimeter Adequacy Determiner															
2092	Telescope Adequacy Determiner															
2093	Camera Adequacy Determiner															
2094	TV System Operation Monitor															
2095	Scanner Operation Monitor															
2096	Radiometer Operation Monitor															
2097	Polarimeter Operation Monitor															
2098	Spectrometer Operation Monitor															
2099	Telescope Operation Monitor															
2100	Atmospheric Pollution Data Classifier															
2101	Water Pollution Data Classifier															
2102	Video Data Quality Evaluator															
	All EO-3 (Air and Water Pollution)															

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [A] = Task-Skill Required by Payload/Experiment.

**No Mission Occupational Skill Assigned; see text and Figure 3-2

Table C-1, p. 3 of 3



TABLE C-2: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-4
(Resource Recognition).

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS											
						CODE	General Technical Skill	Electrical Technician	Systems Engineer, EDP	Instrumentation Technician	Optical Technician	Geophysicist	Meteorologist	Weather Observer	Calibrator	Camera Inspector	Inspector, Systems
CODE	TITLE	EO-4	Resources Recognition				000.000	003.181	003.187	003.281	007.081	024.081	025.088	025.288	710.884	714.684	722.281
0004	Telescope Optics Cleaner																
0036	Spectrometer Control Actuator																
0038	Spectrometer Fault Identifier																
0040	Spectrometer Tester																
0046	Film Cartridge Installer																
0072	Spectrometer Calibrator																
0095	Spectrometer Optics Cleaner																
0097	Camera Lens (Optics) Cleaner																
0109	Spectrometer Module Remover																
0110	Spectrometer Module Installer																
0158	Camera Module Remover																
0160	Camera Module Installer																
0187	Telescope Module Remover																
0188	Telescope Module Installer																
0204	Camera Mode Monitor																
0209	Scanner Mode Monitor																
0245	Camera Control Actuator																
0265	Telescope Mode Selector																
0267	Spectrometer Mode Selector																
0271	Camera Mode Selector																
0294	Camera Inspector																
0297	Telescope Aligner																
0320	Telescope Control Deactuator																
0328	Film Processor*																
0409	Spectrometer Control Deactuator																
0516	Meteorological Condition Observer																
0519	Computer Module Remover																
0520	Computer Module Installer																
0613	Radar Transmitter Tester																
0615	Radar Transmitter Module Remover																
0616	Radar Transmitter Module Installer																
0623	Radar Receiver Module Installer																
0624	Radar Receiver Module Remover																
0627	Radar Receiver Tester																
0637	Radiometer Module Installer																
0638	Radiometer Module Remover																
0641	Radiometer Tester																
0644	Radiometer Mode Monitor																
0653	Polarimeter Mode Monitor																
0664	Radar Transmitter Control Deactuator																
0666	Radar Receiver Control Deactuator																
0673	Radiometer Control Deactuator																
0683	Radar Transmitter Fault Identifier																
0684	Radar Transmitter Repairer																
0685	Radar Receiver Fault Identifier																
0686	Radar Receiver Repairer																
0691	Radiometer Fault Identifier																
0692	Radiometer Repairer																
0779	Spectrometer Repairer																
0787	Spectrometer Mode Monitor																
0795	Electronic Equipment Fault Identifier																
0828	Scanner Inspector																
0829	Radiometer Inspector																
0831	Polarimeter Inspector																
0833	Spectrometer Inspector																

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [A] = Task-Skill Required by Payload/Experiment.

TABLE C-2: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-4 (Resource Recognition).

(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS		OCCUPATIONAL SKILLS	
CODE	TITLE	EO-4	Resources Recognition	CODE	
2063	Polarimeter Aligner			000.000	General Technical Skill
2065	Earth Survey C/D Equipment Repairer			003.181	Electrical Technician
2066	Scanner Repairer			003.187	Systems Engineer, EDP
2067	Polarimeter Repairer			003.281	Instrumentation Technician
2077	Scanner Data Classifier			007.081	Optical Technician
2078	Radiometer Data Classifier			024.081	Geophysicist
2079	Polarimeter Data Classifier			025.088	Meteorologist
2080	Spectrometer Data Classifier			025.288	Weather Observer
2088	Scanner Adequacy Determiner			710.884	Calibrator
2090	Radiometer Adequacy Determiner			714.684	Camera Inspector
2091	Polarimeter Adequacy Determiner			722.281	Inspector, Systems
2092	Telescope Adequacy Determiner			828.281	Electronics Mechanic
2093	Camera Adequacy Determiner			xxx.xxx	Special Spaceflight Skill
2095	Scanner Operation Monitor				
2096	Radiometer Operation Monitor				
2097	Polarimeter Operation Monitor				
2098	Spectrometer Operation Monitor				
2099	Telescope Operation Monitor				
2102	Video Data Quality Evaluator				
2103	Radar Transmitter Mode Monitor				
2104	Radar Receiver Mode Monitor				
2105	Radar Transmitter Mode Recorder				
2106	Radar Receiver Mode Recorder				
2107	Land Use Data Observer				
2108	Land Use Data Evaluator				
2109	Radar Data Classifier				
2110	Telescope Data Classifier				
2111	Spectrometer Adequacy Determiner				
2112	Radar Transmitter Adequacy Determiner				
2113	Radar Receiver Adequacy Determiner				
2114	Radar Operation Monitor				
2115	Land Use Data Classifier				
2116	Earth Surface Landmark Observer				
2117	Earth Surface Landmark Classifier				
All EO-4 (Resource Recognition)					

☐ = Primary Occupational Skill.
 ☒ = Mission Occupational Skill.
 ☒ = Task-Skill Required by Payload/Experiment.



TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment).

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS											
							CODE	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist	Weather Observer	Calibrator
CODE	TITLE	EO-5	Disaster Assessment					000.000	003.181	003.187	003.281	007.081	018.188	024.081	024.081	025.088	025.288	710.884
0001	Telescope Inspector																	
0004	Telescope Optics Cleaner																	
0046	Film Cartridge Installer																	
0054	TV Camera Unstower																	
0096	TV Camera Optics Cleaner																	
0097	Camera Lens (Optics) Cleaner																	
0158	Camera Module Remover																	
0160	Camera Module Installer																	
0187	Telescope Module Remover																	
0188	Telescope Module Installer																	
0204	Camera Mode Monitor																	
0206	Radio Communicator																	
0209	Scanner Mode Monitor																	
0212	TV Camera Mode Monitor																	
0245	Camera Control Actuator																	
0265	Telescope Mode Selector																	
0271	Camera Mode Selector																	
0292	Camera Unstower																	
0294	Camera Inspector																	
0303	Telescope Unstower																	
0320	Telescope Control Deactuator																	
0328	Film Processor *																	
0345	TV System Module Remover																	
0346	TV System Module Installer																	
0516	Meteorological Condition Observer																	
0611	Radar Transmitter Unstower																	
0613	Radar Transmitter Tester																	
0615	Radar Transmitter Module Remover																	
0616	Radar Transmitter Module Installer																	
0623	Radar Receiver Module Installer																	
0624	Radar Receiver Module Remover																	
0627	Radar Receiver Tester																	
0628	Radar Transmitter Unstower																	
0637	Radiometer Module Installer																	
0638	Radiometer Module Remover																	
0641	Radiometer Tester																	
0642	Radiometer Unstower																	
0644	Radiometer Mode Monitor																	
0664	Radar Transmitter Control Deactuator																	
0666	Radar Receiver Control Deactuator																	
0673	Radiometer Control Deactuator																	
0683	Radar Transmitter Fault Identifier																	
0684	Radar Transmitter Repairer																	
0685	Radar Receiver Fault Identifier																	
0686	Radar Receiver Repairer																	
0691	Radiometer Fault Identifier																	
0692	Radiometer Repairer																	
0795	Electronic Equipment Fault Identifier																	
0812	Radar Transmitter Operation Monitor																	
0823	Scanner Unstower																	
0825	Sferics Detector Unstower																	
0828	Scanner Inspector																	
0829	Radiometer Inspector																	
0832	Sferics Detector Inspector																	
0837	Radiometer Calibrator																	

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

*No Occupational Skill Assigned; see text, paragraph 3.2.1

Table C-3, p. 1 of 5

TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS									
CODE	TITLE	EO-5	Disaster Assessment				CODE	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Optical Technician	Surveyor, Geodetic	Geologist	Geophysicist	Meteorologist
0847	Scanner Control Actuator						000.000									
0848	Radiometer Control Actuator						003.181									
0849	Sferics Detector Control Actuator						003.187									
0846	Telescope Control Actuator						003.281									
0848	Camera Control Deactuator						007.081									
0849	Scanner Control Deactuator						018.188									
0852	Film Stower						024.081									
0853	Sferics Detector Control Deactuator						024.081									
0869	Scanner Data Quality Monitor						025.038									
0870	Radiometer Data Quality Monitor						025.288									
0882	Sferics Detector Data Quality Monitor						710.884									
0884	Scanner Optics Cleaner						714.684									
0885	Telescope Fault Identifier						722.281									
0886	Camera Fault Identifier						828.281									
0887	Scanner Fault Identifier						xxx.xxx									
0890	Sferics Detector Fault Identifier															
0891	Optical Equipment Fault Identifier															
0895	Telescope Presentation Observer															
0896	TV Presentation Observer															
0897	Scanner Presentation Observer															
0898	Radiometer Presentation Observer															
0899	TV Camera Control Actuator															
0904	Scanner Module Remover															
0905	Scanner Module Installer															
0916	Scanner Mode Selector															
0917	Radiometer Mode Selector															
0921	Telescope Pointing Controller **															
0922	TV Data Quality Monitor															
0924	Radiometer Optics Cleaner															
0926	Earth Survey C/D Equipment Module Remover															
0927	Earth Survey C/D Equipment Module Installer															
0928	Earth Survey C/D Equipment Fault Identifier															
0932	Radar Transmitter Inspector															
0933	Radar Receiver Inspector															
0934	Radar Presentation Observer															
0935	Radar Transmitter Control Actuator															
0936	Radar Receiver Control Actuator															
0937	Sferics Detector Presentation Observer															
0938	Radar Transmitter Mode Selector															
0939	Radar Receiver Mode Selector															
0940	Sferics Detector Mode Selector															
0941	Forest Fire Disaster Identifier															
0942	Telescope Mode Monitor															
0943	Telescope Mode Recorder															
0944	Radar Data Quality Monitor															
0945	Sferics Detector Optics Cleaner															
0946	Sferics Detector Module Remover															
0947	Sferics Detector Module Installer															
1193	Telescope Repairer															
1194	TV System Repairer															
1195	Camera Repairer															
1344	Camera Operation Monitor															
1498	Camera Tester															
2045	TV Camera Mode Recorder															
2046	Scanner Mode Recorder															

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. ⊠ = Task-Skill Required by Payload/Experiment.

**No Mission Occupational Skill Assigned; see text and Figure 3-2

Table C-3, p. 2 of 5

TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment).
(Continued)

TASK - SKILL		PAYLOADS / EXPERIMENTS		OCCUPATIONAL SKILLS	
CODE	TITLE	EO-5	Disaster Assessment	CODE	
2047	Radiometer Mode Recorder			000.000	General Technical Skill
2050	Camera Status Monitor			003.181	Electrical Technician
2051	Time Elapsed Observer **			003.187	Radio Engineer
2052	TV Camera Status Monitor			003.281	Instrumentation Technician
2056	Atmospheric Pollution Data Evaluator			007.081	Optical Technician
2057	Meteorological Conditions Evaluator			018.188	Surveyor, Geodetic
2058	Mission Events Evaluator **			024.081	Geologist
2059	TV System Inspector			024.081	Geophysicist
2060	TV System Tester			025.088	Meteorologist
2061	Scanner Tester			025.286	Weather Observer
2064	TV System Fault Identifier			710.884	Calibrator
2065	Earth Survey C/D Equipment Repairer			714.684	Camera Inspector
2066	Scanner Repairer			722.281	Inspector, Systems
2068	TV System Control Deactuator			828.281	Electronics Mechanic
2076	TV Data Classifier			xxx.xxx	Special Spaceflight Skill
2077	Scanner Data Classifier				
2078	Radiometer Data Classifier				
2088	Scanner Adequacy Determiner				
2089	TV Camera Adequacy Determiner				
2090	Radiometer Adequacy Determiner				
2092	Telescope Adequacy Determiner				
2093	Camera Adequacy Determiner				
2094	TV System Operation Monitor				
2095	Scanner Operation Monitor				
2096	Radiometer Operation Monitor				
2099	Telescope Operation Monitor				
2103	Radar Transmitter Mode Monitor				
2104	Radar Receiver Mode Monitor				
2105	Radar Transmitter Mode Recorder				
2106	Radar Receiver Mode Recorder				
2109	Radar Data Classifier				
2110	Telescope Data Classifier				
2112	Radar Transmitter Adequacy Determiner				
2113	Radar Receiver Adequacy Determiner				
2118	Sferics Detector Mode Monitor				
2119	Sferics Detector Mode Recorder				
2120	Camera Mode Recorder				
2121	Geological Precursor Data Observer				
2122	Geological Precursor Data Evaluator				
2123	Earthquake Data Observer				
2124	Earthquake Data Evaluator				
2125	Sferics Detector Tester				
2126	Telescope Tester				
2127	Sferics Detector Adequacy Determiner				
2128	Meteorological Precursor Data Observer				
2129	Artificial Precursor Data Observer				
2130	Topographical Precursor Data Observer				
2131	Precursor Disaster Data Observer				
2132	Meteorological Precursor Data Evaluator				
2133	Artificial Precursor Data Evaluator				
2134	Topographical Precursor Data Evaluator				
2135	Precursor Disaster Data Evaluator				
2136	Hurricane Data Observer				
2137	Tornado Data Observer				
2138	Tidal Wave Data Observer				

☐ = Primary Occupational Skill.
☒ = Mission Occupational Skill.
☒ = Task - Skill Required by Payload/Experiment.

****No Mission Occupational Skill Assigned; see text and Figure 3-2**

Table C-3, p. 3 of 5



TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS											

☐ = Primary Occupational Skill. ☒ = Mission Occupational Skill. ☒ = Task-Skill Required by Payload/Experiment.



TABLE C-3: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload EO-5 (Disaster Assessment).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS										OCCUPATIONAL SKILLS																															
CODE	TITLE	EO-5	Disaster Assessment									CODE	000.000	General Technical Skill	003.181	Electrical Technician	003.187	Radio Engineer	003.281	Instrumentation Technician	007.081	Optical Technician	018.188	Surveyor, Geodetic	024.081	Geologist	024.081	Geophysicist	025.088	Meteorologist	025.288	Weather Observer	710.884	Calibrator	714.684	Camera Inspector	722.281	Inspector, Systems	828.281	Electronics Mechanic	xxx.xxx	Special Spaceflight Skill	
2194	Hurricane Data Classifier																																										
2195	Tornado Data Classifier																																										
2196	Tidal Wave Data Classifier																																										
2197	Flood Data Classifier																																										
2198	Volcanic Eruption Data Classifier																																										
2199	Forest Fire Data Classifier																																										
2200	Range Fire Data Classifier																																										
2201	Landslide Data Classifier																																										
2202	Snowslide Data Classifier																																										
2203	Land Subsidence Data Classifier																																										
2204	Drought Data Classifier																																										
2205	Blizzard Data Classifier																																										
2206	Geological Precursor Communicator																																										
2207	Meteorological Precursor Communicator																																										
2208	Artificial Precursor Communicator																																										
2209	Topographical Precursor Communicator																																										
2210	Precursor Disaster Communicator																																										
2211	Earthquake Disaster Communicator																																										
2212	Hurricane Disaster Communicator																																										
2213	Tornado Disaster Communicator																																										
2214	Tidal Wave Disaster Communicator																																										
2215	Flood Disaster Communicator																																										
2216	Volcanic Eruption Disaster Communicator																																										
2217	Forest Fire Disaster Communicator																																										
2218	Range Fire Disaster Communicator																																										
2219	Landslide Disaster Communicator																																										
2220	Snowslide Disaster Communicator																																										
2221	Land Subsidence Disaster Communicator																																										
2222	Drought Disaster Communicator																																										
2223	Blizzard Disaster Communicator																																										
2224	Earthquake Disaster Identifier																																										
2225	Hurricane Disaster Identifier												</																														

☐ = Primary Occupational Skill. ☒ = Mission Occupational Skill. ☒ = Task-Skill Required by Payload/Experiment.



TABLE C-4: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-1 (Biological Experiments).

TASK - SKILL		PAYLOADS/EXPERIMENTS					OCCUPATIONAL SKILLS						
		MS-1 (1)					CODE	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Biochemist	Calibrator
CODE	TITLE						000.000	003.181	003.187	003.281	041.081	710.884	722.281
0026	TV Camera Translocator												
0054	TV Camera Unstower												
0064	TV Camera Stower												
0079	TV Camera Inspector												
0206	Radio Communicator												
0245	Camera Control Actuator												
0306	TV Camera Installer												
0328	Film Processor *												
0334	TV Camera Controller												
0661	TV Camera Remover												
0689	TV Camera Fault Identifier												
0690	TV Camera Repairer												
1049	Materials Analysis Equipment Controller												
1104	Telemetry Equipment Controller												
1129	Atmosphere Supply/Control System Operation Monitor												
1136	Power Conditioning/Distribution Sys. Oper. Mon.												
1139	Power Conditioning/Distribution System Repairer												
1140	Power Conditioning/Distribution Sys. Fault Identifier												
1156	Data Recorder Installer												
1163	Power Conditioning/Distribution System Unstower												
1170	Power Conditioning/Distribution System Stower												
1179	Power Conditioning/Distribution Sys. Con. Actuator												
1366	Sample Holder Installer												
1455	Densitometer Unstower												
1456	Densitometer Translocator												
1457	Densitometer Installer												
1458	Densitometer Remover												
1461	Densitometer Calibrator												
1462	Densitometer Operation Monitor												
1465	Densitometer Fault Identifier												
1466	Densitometer Repairer												
1519	Data Recorder Unstower												
1520	Data Recorder Translocator												
1524	Gas Elimination/Cooling System Installer												
1525	Gas Elimination/Cooling System Unstower												
1526	Gas Elimination/Cooling System Translocator												
1527	Gas Elimination/Cooling System Cleaner												
1528	Gas Elimination/Cooling System Stower												
1529	Gas Elimination/Cooling System Operation Monitor												
1534	Gas Elimination/Cooling System Fault Identifier												
1535	Gas Elimination/Cooling System Repairer												
1536	Cleanup/Refurbishment Equipment Installer												
1537	Cleanup/Refurbishment Equipment Unstower												
1538	Cleanup/Refurbishment Equipment Translocator												
1539	Cleanup/Refurbishment Equipment Stower												
1540	Buffer/Waste Separator Installer												
1541	Buffer/Waste Separator Unstower												
1542	Buffer/Waste Separator Translocator												
1543	Buffer/Waste Separator Cleaner												
1544	Buffer/Waste Separator Stower												
1545	Buffer/Waste Separator Operation Monitor												
1548	Buffer/Waste Separator Fault Identifier												
1551	Buffer Solution Installer												
1552	Buffer Solution Unstower												
1553	Buffer Solution Translocator												

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

*No Occupational Skill Assigned; see text, paragraph 3.2.1

Table C-4, p. 1 of 3



TABLE C-4: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-1 (Biological Experiments).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
CODE	TITLE	MS-1(1)	Separation of Biologicals																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.



TABLE C-4: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-1 (Biological Experiments).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS										OCCUPATIONAL SKILLS									
		MS-1(1)	Separation of Biologicals									CODE	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Biochemist	Calibrator	Inspector, Systems	Electronics Mechanic	Special Spaceflight Skill
2244	Buffer Solution Stower											000.000									
2245	Biological Materials Stower											003.181									
2246	Instrumentation & Control Center Stower											003.187									
2247	Buffer Solution Flow Rate Observer											003.281									
2248	Electrophoretic Column Control Actuator											041.081									
2249	Biological Materials Data Determiner											710.884									
2250	Instrumentation & Control Center Fault Identifier											722.281									
2251	Instrumentation & Control Center Repairer											828.281									
												xxx.xxx									
All MS-1, Biological Experiments																					

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.



TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS									
		MS-2(1)	MS-2(2)	MS-2(3)		CODE	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Calibrator	Inspector, Systems
CODE	TITLE						000.000	003.161	003.187	003.281	011.281	022.081	022.081	710.884	722.281
0026	TV Camera Translocator	△	△				○								
0039	Camera Installer	△	△					○							
0054	TV Camera Unstower	△	△							×					
0064	TV Camera Stower	△	△							×					
0079	TV Camera Inspector	△	△							×					
0206	Radio Communicator	△	△	△					○						○
0245	Camera Control Actuator	△	△	△						×					×
0292	Camera Unstower	△	△	△						×					
0306	TV Camera Installer	△	△					○		×					
0328	Film Processor *	△	△	△						×					
0334	TV Camera Controller	△	△					○		×					
0376	Calorimeter Fault Identifier	△	△							×					
0380	Calorimeter Calibrator	△	△							×					
0391	Calorimeter Operation Monitor	△	△							×					
0392	Calorimeter Control Actuator	△	△							×					
0393	Calorimeter Control Deactuator	△	△							×					
0523	Computer Fault Identifier	△	△	△											×
0540	Computer Repairer	△	△	△											×
0633	TV Camera Tester	△	△	△				○		×					
0661	TV Camera Remover	△	△	△				○		×					
0662	Telemetry Equipment Control Actuator	△	△							×					
0689	TV Camera Fault Identifier	△	△							×					
0690	TV Camera Repairer	△	△							×					
0847	Computer Control Actuator	△	△							×					
0862	Tape Recorder Controller	△	△				○			×					
0886	Camera Fault Identifier	△	△							×					
0899	TV Camera Control Actuator	△	△							×					
0980	Furnace Unstower	△	△	△						×					
0981	Furnace Module Remover	△	△	△				○		×					
0982	Furnace Module Installer	△	△	△				○		×					
0983	Furnace Stower	△	△	△						×					
0984	Furnace Cleaner	△	△	△						×					
0985	Furnace Operation Monitor	△	△	△						×					
0988	Furnace Repairer	△	△	△						×					
0989	Furnace Fault Identifier	△	△	△						×					
1046	Materials Analysis Equipment Calibrator	△	△	△						×					
1048	Materials Analysis Equipment Cleaner	△	△	△						×					
1049	Materials Analysis Equipment Controller	△	△	△						×					
1054	Computer Unstower	△	△	△						×					
1055	Computer Operation Monitor	△	△	△						×					
1058	Environmental Chamber Unstower	△	△	△						×					
1059	Environmental Chamber Module Remover	△	△	△				○		×					
1060	Environmental Chamber Module Installer	△	△	△						×					
1061	Environmental Chamber Stower	△	△	△						×					
1062	Environmental Chamber Cleaner	△	△	△						×					
1065	Environmental Chamber Repairer	△	△	△						×					
1066	Environmental Chamber Fault Identifier	△	△	△						×					
1067	Chill System Installer	△	△	△				○		×					
1068	Chill System Unstower	△	△	△						×					
1069	Chill System Translocator	△	△	△				○		×					
1070	Chill System Remover	△	△	△				○		×					
1073	Chill System Stower	△	△	△						×					
1074	Chill System Operation Monitor	△	△	△						×					
1077	Chill System Repairer	△	△	△						×					
1078	Chill System Fault Identifier	△	△	△						×					

○ = Primary Occupational Skill. × = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments)
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS			OCCUPATIONAL SKILLS	
		MS-2(1) Preparation of Glasses	MS-2(2) Supercool'g/Homoq. Nuclea.	MS-2(3) Crystal Growth/Solutions	CODE	
1091	VHF Power Unit Installer	△	△	△	000.000	General Technical Skill
1092	VHF Power Unit Unstower	△	△	△	003.181	Electrical Technician
1093	VHF Power Unit Translocator	△	△	△	003.187	Radio Engineer
1094	VHF Power Unit Remover	△	△	△	003.281	Instrumentation Technician
1095	VHF Power Unit Module Remover	△	△	△	011.281	Metallurgical Assistant
1096	VHF Power Unit Module Installer	△	△	△	022.081	Chemist, Inorganic
1097	VHF Power Unit Calibrator	△	△	△	022.081	Chemist, Physical
1098	VHF Power Unit Stower	△	△	△	710.884	Calibrator
1099	VHF Power Unit Operation Monitor	△	△	△	722.281	Inspector, Systems
1102	VHF Power Unit Repairer	△	△	△	828.281	Electronics Mechanic
1103	VHF Power Unit Fault Identifier	△	△	△		
1104	Telemetry Equipment Controller	△	△	△		
1127	Atmosphere Supply/Control System Module Remover	△	△	△		
1128	Atmosphere Supply/Control System Module Installer	△	△	△		
1129	Atmosphere Supply/Control System Operation Monitor	△	△	△		
1132	Atmosphere Supply/Control System Repairer	△	△	△		
1133	Atmosphere Supply/Control System Fault Identifier	△	△	△		
1134	Power Conditioning/Distribution Sys. Module Remover	△	△	△		
1135	Power Conditioning/Distribution Sys. Module Installer	△	△	△		
1136	Power Conditioning/Distribution Sys. Oper. Mon.	△	△	△		
1139	Power Conditioning/Distribution System Repairer	△	△	△		
1140	Power Conditioning/Distribution Sys. Fault Identifier	△	△	△		
1141	Environmental Chamber Operation Monitor	△	△	△		
1142	Heat Rejection System Unstower	△	△	△		
1145	Heat Rejection System Stower	△	△	△		
1146	Heat Rejection System Operation Monitor	△	△	△		
1149	Heat Rejection System Repairer	△	△	△		
1150	Heat Rejection System Fault Identifier	△	△	△		
1156	Data Recorder Installer	△	△	△		
1160	Computer Stower	△	△	△		
1162	Atmosphere Supply/Control System Unstower	△	△	△		
1163	Power Conditioning/Distribution System Unstower	△	△	△		
1169	Atmosphere Supply/Control System Stower	△	△	△		
1170	Power Conditioning/Distribution System Stower	△	△	△		
1173	Environmental Chamber Control Actuator	△	△	△		
1174	Atmosphere Supply/Control System Control Actuator	△	△	△		
1175	Furnace Control Actuator	△	△	△		
1179	Power Conditioning/Distribution Sys. Con. Actuator	△	△	△		
1181	Chill System Control Actuator	△	△	△		
1183	VHF Power Unit Control Actuator	△	△	△		
1184	Heat Rejection System Control Actuator	△	△	△		
1195	Camera Repairer	△	△	△		
1203	Atmosphere Analysis Unit Unstower	△	△	△		
1204	Atmosphere Analysis Unit Translocator	△	△	△		
1205	Atmosphere Analysis Unit Installer	△	△	△		
1206	Atmosphere Analysis Unit Remover	△	△	△		
1207	Atmosphere Analysis Unit Stower	△	△	△		
1208	Atmosphere Analysis Unit Module Remover	△	△	△		
1209	Atmosphere Analysis Unit Module Installer	△	△	△		
1210	Atmosphere Analysis Unit Fault Identifier	△	△	△		
1211	Atmosphere Analysis Unit Repairer	△	△	△		
1214	Atmosphere Analysis Unit Control Actuator	△	△	△		
1215	Viewing Device Unstower	△	△	△		
1216	Viewing Device Translocator	△	△	△		
1217	Viewing Device Installer	△	△	△		

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.



TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments)
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
		MS-2(1)	MS-2(2)	MS-2(3)		CODE	000.000	003.181	003.187	003.281	011.281	022.081	022.081	710.884	722.281	828.281																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

○ = Primary Occupational Skill. ✕ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.



TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments)
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS									
						CODE									
		MS-2 (1)	MS-2 (2)	MS-2 (3)			000.000	003.181	003.187	003.281	011.281	022.081	022.081	710.884	722.281
CODE	TITLE						General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Calibrator	Inspector, Systems
1378	Silicate Melt Susceptor Module Installer	△								×					
1394	Crystal Growth Research Evaluator	△	△	△								○	×		
1395	Silicate Melt Susceptor Fault Identifier	△													
1396	Silicate Melt Susceptor Repairer	△													
1398	Silicate Solvent Applier			△								○	×		
1400	Furnace Control Deactuator			△											
1401	Silicate Melt Susceptor Operating Monitor	△													
1415	Crystal Puller Control Actuator			△											
1416	Crystal Puller Unstower			△											
1417	Crystal Puller Translocator			△			○								
1418	Crystal Puller Installer			△				○							
1419	Crystal Puller Remover			△				○							
1422	Crystal Puller Cleaner			△											
1423	Crystal Puller Operation Monitor			△											
1442	Crystal Puller Fault Identifier			△											
1443	Crystal Puller Repairer			△											
1444	Crystal Growth Characteristics Determiner			△											
1445	Crystal Growth Structure Analyzer			△											
1447	Materials Analysis Equipment Tester		△	△								○	×		
1449	Holographic Device Tester	△	△	△				○							
1454	Crystal Growth Data Recorder			△			○					○	×		
1474	Calorimeter Repairer			△											
1479	Calorimeter Remover			△				○							
1480	Calorimeter Installer			△				○							
1481	Calorimeter Translocator			△			○								
1482	Calorimeter Unstower			△											
1483	Friction Measuring Device Repairer			△											
1484	Friction Measuring Device Fault Identifier			△											
1487	Friction Measuring Device Operation Monitor			△											
1488	Friction Measuring Device Calibrator			△											
1491	Friction Measuring Device Remover			△				○						×	
1492	Friction Measuring Device Installer			△				○							
1493	Friction Measuring Device Translocator			△			○								
1494	Friction Measuring Device Unstower			△											
1495	Friction Measuring Device Control Deactuator			△											
1496	Friction Measuring Device Control Actuator			△											
1497	Friction Measuring Device Stower			△											
1498	Friction Measuring Device Cleaner			△											
1499	Calorimeter Stower			△	△										
1500	Calorimeter Cleaner			△											
1505	Heating/Positioning Coil Control Deactuator			△	△										
1507	Atmosphere Analysis Unit Control Deactuator			△											
1508	Holographic Device Control Deactuator			△											
1509	VHF Power Unit Control Deactuator			△											
1512	Crystal Growth Process Monitor			△								○	×		
1513	Glass Samples Unstower			△											
1514	Glass Samples Translocator			△			○								
1515	Glass Samples Installer			△				○							
1516	Glass Samples Remover			△				○							
1517	Glass Samples Stower			△											
1518	Glass Structure Analyzer			△								○	×		
1519	Data Recorder Unstower			△											
1520	Data Recorder Translocator			△											
1521	Glass Processing Research Planner			△								○	×		
1522	Glass Processing Research Evaluator			△								○	×		

○ = Primary Occupational Skill. × = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.



TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments)
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS												
		MS-2(1) Preparation of Glasses	MS-2(2) Supercool'g/Homog. Nuclea.	MS-2(3) Crystal Growth/Solutions				CODE	000.000 General Technical Skill	003.181 Electrical Technician	003.187 Radio Engineer	003.281 Instrumentation Technician	011.281 Metallurgist Assistant	022.081 Chemist, Inorganic	022.081 Chemist, Physical	710.884 Calibrator	722.281 Inspector, Systems	828.281 Electronics Mechanic
CODE	TITLE																	
1549	TV System Control Actuator	△	△															
1550	Data Compression Equipment Control Actuator	△	△															
1986	Atmosphere Supply/Control System Inspector	△	△															
1987	Atmosphere Supply/Control System Tester	△	△															
2068	TV System Control Deactuator	△	△															
2240	Instrumentation & Control Center Unstower	△	△	△														
2246	Instrumentation & Control Center Stower	△	△	△														
2250	Instrumentation & Control Center Fault Identifier	△	△	△														
2251	Instrumentation & Control Center Repairer	△	△	△														
2252	General Purpose Lab Bench Unstower	△	△	△														
2253	Accident Control System Unstower	△	△	△														
2254	Glass Processing Research Coordinator	△	△															
2255	Instrumentation & Control Center Control Actuator	△	△	△														
2256	General Purpose Lab Bench Stower	△	△															
2257	Silicate Melt Susceptor Stower	△	△															
2258	Accident Control System Stower	△	△															
2259	Line Reader Installer	△	△															
2260	General Purpose Lab Bench Control Actuator	△	△	△														
2261	Accident Control System Control Actuator	△	△	△														
2262	Viewing Device Control Actuator	△	△	△														
2263	Glass Processing Research Monitor	△	△															
2264	Accident Control System Operation Monitor	△	△															
2265	General Purpose Lab Bench Fault Identifier	△	△	△														
2266	General Purpose Lab Bench Repairer	△	△	△														
2267	Accident Control System Fault Identifier	△	△	△														
2268	Accident Control System Repairer	△	△	△														
2269	Materials Analysis Equipment Inspector	△	△	△														
2270	Holographic Device Inspector	△	△	△														
2271	Environmental Chamber Inspector	△	△															
2272	Power Conditioning/Distribution System Inspector	△	△															
2273	Calorimeter Inspector	△	△															
2274	Friction Measuring Device Inspector	△	△															
2275	Atmosphere Analysis Unit Inspector	△	△															
2276	Chill System Inspector	△	△															
2277	Heat Rejection System Inspector	△	△															
2278	Heating/Positioning Coils Inspector	△	△															
2279	Viewing Device Inspector	△	△															
2280	VHF Power Unit Inspector	△	△															
2281	Accident Control System Inspector	△	△															
2282	General Purpose Lab Bench Inspector	△	△															
2283	Environmental Chamber Tester	△	△															
2284	Power Conditioning/Distribution System Tester	△	△															
2285	Calorimeter Tester	△	△															
2286	Friction Measuring Device Tester	△	△															
2287	Atmosphere Analysis Unit Tester	△	△															
2288	Chill System Tester	△	△															
2290	Heat Rejection System Tester	△	△															
2291	Heating/Positioning Coil Tester	△	△															
2292	Viewing Device Tester	△	△															
2293	VHF Power Unit Tester	△	△															
2294	Accident Control System Tester	△	△															
2295	Computer Tester	△	△															
2296	Viewing Device Control Deactuator	△	△															
2297	Chill System Control Deactuator	△	△															
2298	Crystal Growth Research Coordinator	△	△															

△ = Primary Occupational Skill. X = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

○ = Primary Occupational Skill. X = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

TABLE C-5: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-2 (Levitation Experiments)
(Continued)

[illegible]

TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload
MS-3 (Furnace Experiments).

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS										
						CODE	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical	Calibrator	Inspector, Systems	Electronics Mechanic
CODE	TITLE	MS-3(1)	Composite Materials	MS-3(2)	Liquid Dispersions											
0026	TV Camera Translocator															
0039	Camera Installer															
0059	TV Camera Unstower															
0064	TV Camera Stower															
0079	TV Camera Inspector															
0206	Radio Communicator															
0245	Camera Control Actuator															
0292	Camera Unstower															
0294	Camera Inspector															
0306	TV Camera Installer															
0314	Camera Remover															
0328	Film Processor *															
0523	Computer Fault Identifier															
0540	Computer Repairer															
0632	TV Camera Tester															
0661	TV Camera Remover															
0662	Telemetry Equipment Control Actuator															
0689	TV Camera Fault Identifier															
0690	TV Camera Repairer															
0847	Computer Control Actuator															
0886	Camera Fault Identifier															
0899	TV Camera Control Actuator															
0968	Composite Materials Research Planner															
0969	Composite Materials Data Recorder															
0971	Composite Materials Structure Analyzer															
0973	Composite Materials Research Evaluator															
0974	Composite Materials Sample Installer															
0975	Composite Materials Sample Unstower															
0976	Composite Materials Sample Translocator															
0977	Composite Materials Sample Remover															
0978	Composite Materials Sample Stower															
0980	Furnace Unstower															
0981	Furnace Module Remover															
0982	Furnace Module Installer															
0983	Furnace Stower															
0984	Furnace Cleaner															
0985	Furnace Operation Monitor															
0988	Furnace Repairer															
0989	Furnace Fault Identifier															
0991	Mixing Unit Installer															
0992	Mixing Unit Unstower															
0993	Mixing Unit Translocator															
0994	Mixing Unit Remover															
0997	Mixing Unit Stower															
0998	Mixing Unit Cleaner															
0999	Mixing Unit Operation Monitor															
1002	Mixing Unit Repairer															
1003	Mixing Unit Fault Identifier															
1016	Materials Forming Equipment Installer															
1017	Materials Forming Equipment Unstower															
1018	Materials Forming Equipment Translocator															
1021	Materials Forming Equipment Cleaner															
1046	Materials Analysis Equipment Calibrator															
1048	Materials Analysis Equipment Cleaner															
1049	Materials Analysis Equipment Controller															

⊙ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

*No Occupational Skill Assigned; see text, paragraph 3.2.1

TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload
MS-3 (Furnace Experiments).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS									
		MS-3 (1)	Composite Materials	MS-3 (2)	Liquid Dispersions										
CODE	TITLE														
1054	Computer Unstower														
1055	Computer Operation Monitor														
1058	Environmental Chamber Unstower														
1059	Environmental Chamber Module Remover														
1060	Environmental Chamber Module Installer														
1061	Environmental Chamber Stower														
1062	Environmental Chamber Cleaner														
1065	Environmental Chamber Repairer														
1066	Environmental Chamber Fault Identifier														
1079	Vibrator Installer														
1080	Vibrator Unstower														
1081	Vibrator Translocator														
1082	Vibrator Remover														
1085	Vibrator Stower														
1086	Vibrator Operation Monitor														
1089	Vibrator Repairer														
1090	Vibrator Fault Identifier														
1091	VHF Power Unit Installer														
1092	VHF Power Unit Unstower														
1093	VHF Power Unit Translocator														
1094	VHF Power Unit Remover														
1095	VHF Power Unit Module Remover														
1096	VHF Power Unit Module Installer														
1098	VHF Power Unit Stower														
1099	VHF Power Unit Operation Monitor														
1102	VHF Power Unit Repairer														
1103	VHF Power Unit Fault Identifier														
1105	Dispersion Control System Unstower														
1107	Dispersion Control System Stower														
1109	Dispersion Control System Cleaner														
1110	Dispersion Control System Operation Monitor														
1113	Dispersion Control System Repairer														
1114	Dispersion Control System Fault Identifier														
1115	Slip Cast Injection System Installer														
1116	Slip Cast Injection System Unstower														
1117	Slip Cast Injection System Translocator														
1118	Slip Cast Injection System Remover														
1122	Slip Cast Injection System Operation Monitor														
1125	Slip Cast Injection System Repairer														
1126	Slip Cast Injection System Fault Identifier														
1127	Atmosphere Supply/Control System Module Remover														
1128	Atmosphere Supply/Control System Module Installer														
1129	Atmosphere Supply/Control System Operation Monitor														
1132	Atmosphere Supply/Control System Repairer														
1133	Atmosphere Supply/Control System Fault Identifier														
1134	Power Conditioning/Distribution Sys. Module Remover														
1135	Power Conditioning/Distribution Sys. Module Installer														
1136	Power Conditioning/Distribution Sys. Oper. Mon.														
1139	Power Conditioning/Distribution System Repairer														
1140	Power Conditioning/Distribution Sys. Fault Identifier														
1141	Environmental Chamber Operation Monitor														
1142	Heat Rejection System Unstower														
1145	Heat Rejection System Stower														
1146	Heat Rejection System Operation Monitor														
1149	Heat Rejection System Repairer														

○ = Primary Occupational Skill. ⊗ = Mission Occupational Skill. △ = Task-Skill Required by Payload/Experiment.

TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload
MS-3 (Furnace Experiments).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS				OCCUPATIONAL SKILLS							
		MS-3 (1)	Composite Materials	MS-3 (2)	Liquid Dispersions	CODE	General Technical Skill	Electrical Technician	Radio Engineer	Instrumentation Technician	Metallurgist Assistant	Chemist, Inorganic	Chemist, Physical
CODE	TITLE						000.000	003.181	003.187	003.281	011.281	022.081	022.081
1150	Heat Rejection System Fault Identifier												
1156	Data Recorder Installer												
1160	Computer Stower												
1162	Atmosphere Supply/Control System Unstower												
1163	Power Conditioning/Distribution System Unstower												
1169	Atmosphere Supply/Control System Stower												
1170	Power Conditioning/Distribution System Stower												
1173	Environmental Chamber Control Actuator												
1174	Atmosphere Supply/Control System Control Actuator												
1175	Furnace Control Actuator												
1176	Dispersion Control System Control Actuator												
1177	Mixing Unit Control Actuator												
1179	Power Conditioning/Distribution Sys. Con. Actuator												
1183	VHF Power Unit Control Actuator												
1184	Heat Rejection System Control Actuator												
1195	Camera Repairer												
1203	Atmosphere Analysis Unit Unstower												
1204	Atmosphere Analysis Unit Translocator												
1205	Atmosphere Analysis Unit Installer												
1206	Atmosphere Analysis Unit Remover												
1207	Atmosphere Analysis Unit Stower												
1208	Atmosphere Analysis Unit Module Remover												
1209	Atmosphere Analysis Unit Module Installer												
1210	Atmosphere Analysis Unit Fault Identifier												
1211	Atmosphere Analysis Unit Repairer												
1214	Atmosphere Analysis Unit Control Actuator												
1226	Camera Translocator												
1229	Holographic Device Control Actuator												
1232	Holographic Device Repairer												
1233	Holographic Device Fault Identifier												
1237	Holographic Device Remover												
1238	Holographic Device Installer												
1239	Holographic Device Translocator												
1240	Holographic Device Unstower												
1254	Metal Sample Installer												
1255	Metal Sample Remover												
1256	Metal Sample Translocator												
1257	Metal Sample Unstower												
1259	Heating/Positioning Coil Operation Monitor												
1260	Heating/Positioning Coil Control Actuator												
1263	Heating/Positioning Coil Repairer												
1264	Heating/Positioning Coil Fault Identifier												
1268	Heating/Positioning Coil Remover												
1269	Heating/Positioning Coil Installer												
1270	Heating/Positioning Coil Translocator												
1271	Heating/Positioning Coil Unstower												
1336	Heating/Positioning Coil Cleaner												
1343	Atmosphere Analysis Unit Operation Monitor												
1346	Liquid Dispersion Research Planner												
1347	Slip Formulation Controller												
1348	Slip Materials Stower												
1351	Slip Materials Remover												
1353	Liquid Dispersion Research Evaluator												
1358	Slip Casting Remover												
1359	Slip Casting Stower												

☒ = Primary Occupational Skill. ☒ = Mission Occupational Skill. ☒ = Task-Skill Required by Payload/Experiment.

TABLE C-6: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-3 (Furnace Experiments) .
(Continued)

[illegible]

TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload M5-4 (Small and Low Temperature Experiments).

TASK - SKILL		PAYLOADS/EXPERIMENTS			OCCUPATIONAL SKILLS																		
CODE	TITLE	MS-4(1)	Fluids Convection	MS-4(2)	Crystal Growth/Melts																		
																							</

*No Occupational Skill Assigned; see text, paragraph 3.2.1

Table C-7, p. 1 of 5

TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortle Lab Payload MS-4
(Small and Low Temperature Experiments).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS		OCCUPATIONAL SKILLS	
CODE	TITLE	MS-4(1) Fluids Convection	MS-4(2) Crystal Growth/Melts	CODE	General Technical Skill
1079	Vibrator Installer			000.000	
1080	Vibrator Unstower			003.181	
1081	Vibrator Translocator			003.187	
1082	Vibrator Remover			003.281	
1086	Vibrator Operation Monitor			011.281	
1089	Vibrator Repairer			022.081	
1090	Vibrator Fault Identifier			022.081	
1091	VHF Power Unit Installer			022.081	
1092	VHF Power Unit Unstower			023.081	
1093	VHF Power Unit Translocator			710.834	
1094	VHF Power Unit Remover			722.281	
1095	VHF Power Unit Module Remover			828.281	
1096	VHF Power Unit Module Installer				
1097	VHF Power Unit Calibrator				
1099	VHF Power Unit Operation Monitor				
1102	VHF Power Unit Repairer				
1103	VHF Power Unit Fault Identifier				
1105	Dispersion Control System Unstower				
1109	Dispersion Control System Cleaner				
1110	Dispersion Control System Operation Monitor				
1113	Dispersion Control System Repairer				
1114	Dispersion Control System Fault Identifier				
1127	Atmosphere Supply/Control System Module Remover				
1128	Atmosphere Supply/Control System Module Installer				
1129	Atmosphere Supply/Control System Operation Monitor				
1132	Atmosphere Supply/Control System Repairer				
1133	Atmosphere Supply/Control System Fault Identifier				
1134	Power Conditioning/Distribution Sys. Module Remover				
1135	Power Conditioning/Distribution Sys. Module Installer				
1136	Power Conditioning/Distribution Sys. Oper. Mon.				
1139	Power Conditioning/Distribution System Repairer				
1140	Power Conditioning/Distribution Sys. Fault Identifier				
1141	Environmental Chamber Operation Monitor				
1142	Heat Rejection System Unstower				
1146	Heat Rejection System Operation Monitor				
1149	Heat Rejection System Repairer				
1150	Heat Rejection System Fault Identifier				
1156	Data Recorder Installer				
1162	Atmosphere Supply/Control System Unstower				
1163	Power Conditioning/Distribution System Unstower				
1173	Environmental Chamber Control Actuator				
1174	Atmosphere Supply/Control System Control Actuator				
1175	Furnace Control Actuator				
1177	Mixing Unit Control Actuator				
1179	Power Conditioning/Distribution Sys. Con. Actuator				
1182	Vibrator Control Actuator				
1183	VHF Power Unit Control Actuator				
1184	Heat Rejection System Control Actuator				
1195	Camera Repairer				
1226	Camera Translocator				
1227	Holographic Device Calibrator				
1228	Holographic Device Operation Monitor				
1229	Holographic Device Control Actuator				
1232	Holographic Device Repairer				
1233	Holographic Device Fault Identifier				

[0] = Primary Occupational Skill. [X] = Mission Occupational Skill. [X] = Task-Skill Required by Payload/Experiment.



TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-4
(Small and Low Temperature Experiments).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS			OCCUPATIONAL SKILLS											
		MS-4(1)	MS-4(2)		CODE	000.000	000.181	003.187	003.281	011.281	022.081	023.081	710.884	722.281	828.281	
1234	Holographic Device Module Installer															
1237	Holographic Device Remover															
1238	Holographic Device Installer															
1239	Holographic Device Translocator															
1240	Holographic Device Unstower															
1241	Heating/Cooling Device Operation Monitor															
1242	Heating/Cooling Device Control Actuator															
1245	Heating/Cooling Device Repairer															
1246	Heating/Cooling Device Fault Identifier															
1250	Heating/Cooling Device Remover															
1251	Heating/Cooling Device Installer															
1252	Heating/Cooling Device Translocator															
1253	Heating/Cooling Device Unstower															
1345	TV Camera Operation Monitor															
1354	Materials Sample Unstower															
1355	Materials Sample Translocator															
1356	Materials Sample Installer															
1357	Materials Sample Remover															
1367	Crystal Growth Research Planner															
1368	Crystal Growth Observer															
1371	Materials Sample Stower															
1394	Crystal Growth Research Evaluator															
1405	Zone Melter Control Actuator															
1406	Zone Melter Unstower															
1407	Zone Melter Translocator															
1408	Zone Melter Installer															
1410	Zone Melter Module Remover															
1411	Zone Melter Module Installer															
1412	Zone Melter Cleaner															
1413	Zone Melter Operation Monitor															
1415	Crystal Puller Control Actuator															
1416	Crystal Puller Unstower															
1417	Crystal Puller Translocator															
1418	Crystal Puller Installer															
1419	Crystal Puller Remover															
1422	Crystal Puller Cleaner															
1423	Crystal Puller Operation Monitor															
1425	Zone Refiner Control Actuator															
1426	Zone Refiner Unstower															
1427	Zone Refiner Translocator															
1428	Zone Refiner Installer															
1430	Zone Refiner Module Remover															
1431	Zone Refiner Module Installer															
1432	Zone Refiner Cleaner															
1433	Zone Refiner Operation Monitor															
1436	Zone Refiner Fault Identifier															
1437	Zone Refiner Repairer															
1439	Zone Melter Fault Identifier															
1440	Zone Melter Repairer															
1442	Crystal Puller Fault Identifier															
1443	Crystal Puller Repairer															
1444	Crystal Growth Characteristics Determiner															
1445	Crystal Growth Structure Analyzer															
1446	Test Cell Installer															
1447	Materials Analysis Equipment Tester															

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [] = Task-Skill Required by Payload/Experiment.

TABLE C-7: Correlation of Task-Skills with Occupational Skills, Sortie Lab Payload MS-4
(Small and Low Temperature Experiments).
(Continued)

TASK - SKILL		PAYLOADS/EXPERIMENTS		OCCUPATIONAL SKILLS	
CODE	TITLE	MS-4(1) Fluids Convection	MS-4(2) Crystal Growth/Melts	CODE	General Technical Skill Electrical Technician Radio Engineer Instrumentation Technician Metallurgist Assistant Chemist, Inorganic Chemist, Physical Physicist, Heat Calibrator Inspector, Systems Electronics Mechanic
1448	Camera Tester			000.000	
1449	Holographic Device Tester			003.181	
1474	Calorimeter Repairer			003.187	
1479	Calorimeter Remover			003.281	
1480	Calorimeter Installer			011.281	
1481	Calorimeter Translocator			022.081	
1482	Calorimeter Unstower			022.081	
1500	Calorimeter Cleaner			023.081	
1512	Crystal Growth Process Monitor			710.884	
1519	Data Recorder Unstower			722.281	
1520	Data Recorder Translocator			828.281	
1601	Interferometer Installer				
1602	Interferometer Unstower				
1603	Interferometer Translocator				
1604	Interferometer Remover				
1605	Interferometer Calibrator				
1606	Interferometer Tester				
1609	Interferometer Operation Monitor				
1614	Interferometer Fault Identifier				
1615	Interferometer Repairer				
1616	Interferometer Control Actuator				
1647	Fluid Sample Mixing Controller				
1648	Fluid Convection Research Planner				
1649	Fluid Convection Research Evaluator				
1650	Fluid Samples Installer				
1651	Fluid Samples Translocator				
1652	Fluid Samples Unstower				
1653	Fluid Samples Remover				
2240	Instrumentation & Control Center Unstower				
2243	Interferometer Inspector				
2250	Instrumentation & Control Center Fault Identifier				
2251	Instrumentation & Control Center Repairer				
2252	General Purpose Lab Bench Unstower				
2253	Accident Control System Unstower				
2255	Instrumentation & Control Center Control Actuator				
2260	General Purpose Lab Bench Control Actuator				
2261	Accident Control System Control Actuator				
2264	Accident Control System Operation Monitor				
2265	General Purpose Lab Bench Fault Identifier				
2266	General Purpose Lab Bench Repairer				
2267	Accident Control System Fault Identifier				
2268	Accident Control System Repairer				
2269	Materials Analysis Equipment Inspector				
2270	Holographic Device Inspector				
2298	Crystal Growth Research Coordinator				
2303	Crystal Growth Research Monitor				
2306	Heating/Cooling Device Cleaner				
2310	Dispersion Control System Translocator				
2311	Dispersion Control System Installer				
2312	Dispersion Control System Remover				
2313	Dispersion Control System Calibrator				
2328	Fluid Connection Research Coordinator				
2329	Fluid Connection Research Monitor				
2330	Test Cell Translocator				
2331	Test Cell Unstower				

[O] = Primary Occupational Skill. [X] = Mission Occupational Skill. [] = Task-Skill Required by Payload/Experiment.

THE

☐ = Primary Occupational Skill. ☒ = Mission Occupational Skill. ☐ = Task-Skill Required by Payload/Experiment.

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

**APPENDIX C
WORKSTATION CONCEPTS SUPPORTING DATA**



APPENDIX D

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

EXPLANATION OF TASK DEPENDENCY REFERENCE LIST

During the analysis of crew functions (paragraph 2.2.4), a determination was made of the major types of factors upon which successful task performance depended. These major factors were categorized as:

1. System and Facilities
2. Experiment Equipment and Materials
3. Object or Area Under Investigation
4. Support Equipment
5. Environment
6. Mission Considerations

The six major categories of task dependencies were divided into subcategories based on major functional differences. Then, as each new item of equipment or object of investigation was identified, it was placed in one of the subcategories. Each item was given an alphanumeric code designation to permit ready recognition of the category and subcategory to which it belonged and to promote rapid data retrieval. In addition to these three levels, a fourth level was assigned, where appropriate, to identify specific equipment items, or characteristics. For example, within the major category of "Experiment Equipment" (#2), the second level might be "Observation Equipment" (#2.A), and the third level of dependency could be "Spectrometers" (#2.A.03). The fourth level, then, would be various specific types of spectrometers and each type would be assigned a dash number, e.g. "Ion Mass Spectrometer" (#2.A.03-6). An illustration of the structure and use of the Task Dependency Reference System is shown in the following diagram. The complete Task Dependency Reference List comprises the remainder of this appendix to the report.

LEVEL #1
LEVEL #2
1. System and Facilities

- A. R-4
- B. Orbiter
- C. Booster
- D. Ground Control
- E. Satellite
- F. Space Station

2. Experiment Materials and Equipment

- A. Observation Equipment
- B. Control/Display Equipment
- C. Experiment Materials
- D. Materials Control Equipment
- E. Accessory Equipment
- F. Experiment Records & Data
- G. Internal Spacecraft Systems

3. Object or Area Under Investigation

- A. Solar
- B. Stellar
- C. Earth Surface
- D. Man-Biological/Physiological Aspects
- E. Spacecraft (Physical & Structural)
- F. Extravehicular Space Environment
- G. Planetary
- H. Lunar
- I. Processes in Zero Gravity
- J. Processes in Vacuum
- K. Communication Processes & Equipment
- L. Navigation Processes & Equipment
- M. Teleoperations
- N. Life Support & Habitability Systems
- O. Man-Performance Capability Aspects

4. Support Equipment

- A. Communications Equipment
- B. Data Processing Equipment
- C. Test and Checkout Equipment
- D. Miscellaneous Support Equipment
- E. Life Support & Protective Equipment
- F. Subsatellites

5. Environment

- A. Acceleration and Gravity
- B. Illumination
- C. Pressure
- D. Temperature
- E. Noise
- F. Radiation (Ionizing)
- G. Radiation (Radio Frequency)
- H. Extravehicular Environment ($B + C + D \pm [F + G]$)
- I. Earth Atmosphere
- J. Fire and/or Explosion Hazard
- K. Intravehicular Activity Environment ($B + C + D$)
- L. Object/Vehicle Relationship

6. Mission Considerations

- A. Mission Events

LEVEL #3

- 01 Telescopes
- 02 Photometers
- 03 Spectrometers
- 04 Television
- 05 Image Tube Optical Systems
- 06 Gas Temperature Chambers
- 07 Ion Traps
- 08 Probes
- 09 Magnetometers
- 10 VLE Sensors
- 11 Particle and Meteoroid Sensors/Analyzers
- 12 Transmitter/Receivers/Antennas
- 13 Molecular Beam Scattering Device
- 14 Optical Gratings
- 15 Band Filters
- 16 Gas-Surface Interaction Device
- 17 Film Cameras
- 18 Microscopes
- 19 Attitude Measuring Equipment

LEVEL #4

- 1 Michelson Infrared Interferometer Spectrometer
- 2 75 cm Scanning Grating Spectrometer
- 3 Grazing Incidence EVA Spectrometer
- 4 Open Source Mass Spectrometer
- 5 Closed Source Mass Spectrometer
- 6 Ion Mass Spectrometer
- 7 EVA Spectrometer (Type Unspecified)
- 8 Scanning Spectrometer (Type Unspecified)
- 9 Infrared (I.R.) Spectrometer (Type Unspecified)
- 10 Ultraviolet (U.V.) Spectrometer (Type Unspecified)
- 11 Mass Scanning Spectrometer
- 12 Multispectral Spectrometer
- 13 Multispectral Spectrometer
- 14 Astronomy Spectrometer
- 15 Absorption Spectrometer

- 1 Field Cameras
- 2 Spectrograph Cameras
- 3 Metric Camera
- 4 Multispectral Camera
- 5 16 mm Time-Lapse Movie Camera
- 6 Stellar Camera
- 7 16 mm Movie Camera

- 1 Optical Spectrometer Calibration Lamps
- 2 Mass Spectrometer Calibration Gases
- 3 Gas Chromatograph Calibration Gases

- 01 Calibration Equipment And Materials
- 02 Electrical And Electronic Equipment Test Equipment
- 03 Laser Transmitter/Receiver Test Equipment
- 04 Radar Transmitter/Receiver Test Equipment
- 05 Radio Transmitter/Receiver Test Equipment
- 06 Millimeter Wave Transmitter/Receiver Test Equipment
- 07 Optical Equipment Test Equipment

- 1 Oscilloscopes
- 2 Digital Multimeters
- 3 Function Generators

TDR
CODE

- 2.A.03-1
- 2.A.03-2
- 2.A.03-3
- 2.A.03-4
- 2.A.03-5
- 2.A.03-6
- 2.A.03-7
- 2.A.03-8
- 2.A.03-9
- 2.A.03-10
- 2.A.03-11
- 2.A.03-12
- 2.A.03-13
- 2.A.03-14
- 2.A.03-15

- 2.A.17-1
- 2.A.17-2
- 2.A.17-3
- 2.A.17-4
- 2.A.17-5
- 2.A.17-6
- 2.A.17-7

- 4.C.01-1
- 4.C.01-2
- 4.C.01-3

- 4.C.02-1
- 4.C.02-2
- 4.C.02-3

EXAMPLE OF TASK DEPENDENCY REFERENCE LIST (TDRL)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

1. SYSTEM AND FACILITIES

1.A Research and Application Module (RAM)

1.A.01 RAM Structure

- 1.A.01-1 Locomotion Aids
- 1.A.01-2 Passageways
- 1.A.01-3 Airlock Latches
- 1.A.01-4 Airlock Cable Feedthroughs
- 1.A.01-5 Extendible Rail/Boom Instrument Mounting Platforms
- 1.A.01-6 Stability Aids (Dutch Shoes, etc.)
- 1.A.01-7 Interior Instrument Mounting Platforms
- 1.A.01-8 Exterior Surface Instrument Mounting Platforms
- 1.A.01-9 Extendible Rail/Boom
- 1.A.01-10 Airlock
- 1.A.01-11 Airlock Hatch Cover
- 1.A.01-12 Telescope Chamber
- 1.A.01-13 Telescope Chamber Hatch
- 1.A.01-14 Viewing Ports
- 1.A.01-15 External Surfaces
- 1.A.01-16 Reaction Control System
- 1.A.01-17 Airlock Mounting Platforms
- 1.A.01-18 Interior Surfaces

1.A.02 RAM System Controls and Displays

- 1.A.02-1 Airlock Security Displays
- 1.A.02-2 Airlock Pressure Displays and Controls
- 1.A.02-3 Airlock Latch Controls (Remote Actuating) and Displays
- 1.A.02-4 Extendible Rails/Boom Controls
- 1.A.02-5 Extendible Rails/Boom Status and Position Displays
- 1.A.02-6 Rail/Boom Instrument Platform Position/Orientation Displays/Controls
- 1.A.02-7 Telescope Chamber Security Displays
- 1.A.02-8 Telescope Chamber Pressure Displays and Controls
- 1.A.02-9 Telescope Chamber Temperature Displays and Controls
- 1.A.02-10 Telescope Chamber Hatch Controls (Remote Actuating)

1.A.03 RAM Facility Equipment

- 1.A.03-1 Instrument/Equipment Storage Cabinets
- 1.A.03-2 Toxic Materials Storage Cabinets
- 1.A.03-3 Data Storage Cabinets
- 1.A.03-4 Water Recovery System
- 1.A.03-5 Waste Management System
- 1.A.03-6 Cooling System
- 1.A.03-7 (Not Assigned)
- 1.A.03-8 Atmosphere Supply and Control System
- 1.A.03-9 Carbon Dioxide Collection System

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TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

1. SYSTEM AND FACILITIES (Continued)
 - 1.G Sortie Lab
 - 1.G.01 Sortie Lab Structure
 - 1.G.01-10 Airlock
 - 1.G.01-11 Airlock Hatch Cover
 - 1.G.01-12 Telescope Chamber
 - 1.G.01-13 Telescope Chamber Hatch
 - 1.G.01-14 Viewing Ports
 - 1.G.01-15 External Surfaces
 - 1.G.01-16 Reaction Control System
 - 1.G.01-17 Airlock Mounting Platforms
 - 1.G.01-18 Interior Surfaces
 - 1.G.02 Sortie Lab Module Controls and Displays
 - 1.G.02-1 Airlock Security Displays
 - 1.G.02-2 Airlock Pressure Displays and Controls
 - 1.G.02-3 Airlock Latch Controls (Remote Actuating) and Displays
 - 1.G.02-4 Extendible Rails/Boom Controls
 - 1.G.02-5 Extendible Rails/Boom Status and Position Displays
 - 1.G.02-6 Rail/Boom Instrument Platform Position/Orientation Displays/Controls
 - 1.G.02-7 Telescope Chamber Security Displays
 - 1.G.02-8 Telescope Chamber Pressure Displays and Controls
 - 1.G.02-9 Telescope Chamber Temperature Displays and Controls
 - 1.G.02-10 Telescope Chamber Hatch Controls (Remote Actuating)
 - 1.G.02-11 Mission Status Displays and Controls
 - 1.G.02-11.1 Mission Clock
 - 1.G.02-12 Telemetry Controls and Displays
 - 1.G.02-13 (MS) Accident Control System Controls and Displays
 - 1.G.02-14 (MS) Heat Rejection System Controls and Displays
 - 1.G.03 Sortie Lab Module Facility Equipment
 - 1.G.03-1 Instrument/Equipment Storage Cabinets
 - 1.G.03-2 Toxic Materials Storage Cabinets
 - 1.G.03-3 Data Storage Cabinets
 - 1.G.03-4 Water Recovery System
 - 1.G.03-5 Waste Management System
 - 1.G.03-6 Cooling System
 - 1.G.03-7 (Not Assigned)
 - 1.G.03-8 Atmosphere Supply and Control System
 - 1.G.03-9 Carbon Dioxide Collection System
 - 1.G.03-10 Medical Research Facility/Equipment
 - 1.G.03-11 (Not Assigned)
 - 1.G.03-12 Food Storage, Preparation and Feeding Equipment

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS
 - 2.A Observation Equipment
 - 2.A.01 Telescopes
 - 2.A.01-1 0.9 M. Narrow Field UV Telescope
 - 2.A.01-2 16 Inch Cassegrain Telescope
 - 2.A.01-3 Wide Field UV Telescope
 - 2.A.01-4 Special Aiming Telescope (Comm/Nav Acquisition Aid)
 - 2.A.01-5 Observation Telescope (Earth Observations)
 - 2.A.02 Photometers
 - 2.A.02-1 Photometric Instrument Cluster (Single Beam, Large Aperture)
 - 2.A.02-2 Spectrophotometer
 - 2.A.03 Spectrometers
 - 2.A.03-1 Michelson Infrared Interferometer Spectrometer
 - 2.A.03-2 75 CM Scanning Grating Spectrometer (Ebert-Fastie or Zerny-Turner)
 - 2.A.03-3 Grazing Incidence EUV Spectrometer
 - 2.A.03-4 Open Source Mass Spectrometer
 - 2.A.03-5 Closed Source Mass Spectrometer
 - 2.A.03-6 Ion Mass Spectrometer
 - 2.A.03-7 EUV Spectrometer (Type Unspecified)
 - 2.A.03-8 Scanning Spectrometer (Type Unspecified)
 - 2.A.03-9 Infrared (IR) Spectrometer (Type Unspecified)
 - 2.A.03-10 Ultraviolet (UV) Spectrometer (Type Unspecified)
 - 2.A.03-11 Mass Scanning Spectrometer
 - 2.A.03-12 Mass Spectrometer (Type Unspecified)
 - 2.A.03-13 Multispectral Spectrometer
 - 2.A.03-14 Aeronomy Spectrometer
 - 2.A.03-15 Absorption Spectrometer
 - 2.A.04 Television Systems
 - 2.A.04-1 Image Isocon TV System
 - 2.A.04-2 Multispectral TV System
 - 2.A.04-3 TV Camera, Standard Hi Resolution
 - 2.A.05 Image Tube Optical Systems
 - 2.A.05-1 Space Image Tube Optical System W/Schmidt Corrector Plate
 - 2.A.06 Gas Temperature Chambers
 - 2.A.06-1 Neutral Gas Temperature Chambers
 - 2.A.07 Ion Traps
 - 2.A.07-1 Planar Ion Trap
 - 2.A.08 Probes
 - 2.A.08-1 Electrostatic Probe

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.A Observation Equipment (Continued)
- 2.A.08 Probes
- 2.A.08-2 Electric Field Probe
- 2.A.08-3 Electron Probe
- 2.A.09 Magnetometers
- 2.A.09-1 Flux Gate Magnetometer
- 2.A.09-2 Magnetometer Search Coil
- 2.A.10 VLF Sensors
- 2.A.10-1 (Undefined - See P-1 and P-2)
- 2.A.11 Particle and Meteoroid Sensors/Analyzers
- 2.A.11-1 Aluminum Foil Exposure Device
- 2.A.11-2 Cluster, Electron and Proton Detectors
- 2.A.11-3 Thick Aluminum Hinged Recovery Panels
- 2.A.11-4 Cosmic Dust Analyzer Target Plate Assembly
- 2.A.11-5 Cosmic Dust Analyzer Ion Collector
- 2.A.11-6 Optical Meteoroid Detector
- 2.A.11-7 Small Meteoroid Mass and Velocity Sensor Arrays
- 2.A.11-8 Thick Material Meteoroid Penetration Device (TMMPD)
- 2.A.12 Transmitter/Receivers/Antennas
- 2.A.12-1 Laser Communication Transmitter
- 2.A.12-2 Laser Communication Receiver
- 2.A.12-3 Millimeter Wave Antennas and Antenna Feeds (Radio)
- 2.A.12-4 Millimeter Wave Transmitter (Radio)
- 2.A.12-5 Millimeter Wave Receiver (Radio)
- 2.A.12-6 Emergency Location Transmitter (ELT) Transponder (Radio)
- 2.A.12-7 Interferometer Antenna Array (Radio)
- 2.A.12-8 VHF Transmitter (Radio)
- 2.A.12-9 L-Band Transmitter (Radar)
- 2.A.12-10 VHF Receiver (Radio)
- 2.A.12-11 L-Band Receiver (Radar)
- 2.A.12-12 VHF Antennas (Radio)
- 2.A.12-13 Frequency Synthesizer (Radio)
- 2.A.12-14 Laser Radar Transmitter
- 2.A.12-15 Laser Radar Receiver
- 2.A.12-16 Microwave Radar Transmitter
- 2.A.12-17 Microwave Radar Receiver
- 2.A.12-18 X-Band Transmitter (Radar)
- 2.A.12-19 X-Band Receiver (Radar)
- 2.A.12-20 Narrow Beam Tracking Antenna (Radar)
- 2.A.12-21 Broad Beam Transmitting Antenna (Radar)
- 2.A.12-22 X-Band Transmitter Antenna (Radar)
- 2.A.12-23 L-Band Antennas (Radar)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)

2.A. Observation Equipment (Continued)

2.A.13 Molecular Beam Scattering Devices

2.A.14 Optical Gratings

2.A.14-1 Fine Optical Gratings

2.A.14-2 Coarse Optical Gratings

2.A.15 Band Filters

2.A.15-1 Narrow Band Filters

2.A.15-2 Broad Band Filters

2.A.16 Gas-Surface Interaction Device

2.A.16-1 Test Surfaces

2.A.16-2 Test Surface Blocks

2.A.16-3 Plating Materials Boats

2.A.17 Film Cameras

2.A.17-1 Field Cameras

2.A.17-2 Spectrograph Cameras

2.A.17-3 Metric Camera

2.A.17-4 Multispectral Camera

2.A.17-5 16 mm Time-Lapse Movie Camera

2.A.17-6 Stellar Camera

2.A.17-7 16 mm Movie Camera

2.A.18 Microscopes

2.A.18-1 Phase-Contrast Microscope

2.A.19 Scanners

2.A.19-1 Multispectral Scanner

2.A.19-2 Passive Microwave Scanner

2.A.20 Plethysmographs

2.A.20-1 Leg Volume Plethysmograph

2.A.21 Radiometers

2.A.21-1 Microwave Mapping Radiometers

2.A.21-2 Multispectral Radiometer

2.A.22 Scatterometers

2.A.22-1 Scatterometer/Radiometer

2.A.23 Polarimeters

2.A.24 Sferics Detector

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.A Observation Equipment (Continued)
- 2.A.25 Refractometers
- 2.A.25-1 Goldberg Refractometer (AO)
- 2.A.26 Body Temperature Measurement Devices
- 2.A.26-1 Thermometers
- 2.A.26-2 Thermocouples
- 2.A.26-3 Ear Canal Temperature Probe
- 2.A.27 Film
- 2.A.27-1 Metric Camera Film
- 2.A.27-2 Multispectral Camera Film
- 2.A.27-3 Radiometer Film
- 2.A.27-4 TV Camera Film
- 2.A.27-5 Telescope Camera Film
- 2.A.27-6 16mm Camera Film
- 2.A.28 Spectrographs
- 2.A.29 Gas Chromatograph
- 2.A.30 Calorimeter
- 2.A.30-1 High Temperature Calorimeter
(Differential Thermal Analyzer)
- 2.A.31 Contamination Coupons
- 2.A.32 Body Mass Measurement Device
- 2.A.33 Blood Test/Measurement Device and Equipment
- 2.A.34 Food Moisture Measurement Device
- 2.A.35 Body Waste Measurement Devices and Equipment
- 2.A.36 X-Ray Analysis Equipment
- 2.A.36-1 Radionuclide Bone-Scanner
- 2.A.36-2 Isotope Tracer-Counter
- 2.A.37 Ergometers
- 2.A.37-1 Bicycle Ergometer (Skylab M171 Model)
- 2.A.38 Biological Contamination Sampling Equipment
- 2.A.38-1 Reynier Plates
- 2.A.38-2 Reynier Sampler
- 2.A.38-3 Agar Plates
- 2.A.38-4 Rodac Plates

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
 - 2.A Observation Equipment (Continued)
 - 2.A.38 Biological Contamination Sampling Equipment (Continued)
 - 2.A.38-5 Gram Staining Equipment
 - 2.A.38-6 Nutrient Broth
 - 2.A.38-7 Differential/Selective Media
 - 2.A.39 Interferometers
 - 2.A.39-1 Holographic Interferometer
 - 2.A.39-2 Schlieren Optical Interferometer
 - 2.A.40 Densitometers
 - 2.A.40-1 Photometric Densitometer
 - 2.A.40-2 Ultraviolet (UV) Densitometer
 - 2.A.41 Biomedical Measurements Instruments
 - 2.A.41-1 EVA/Biomedical Measurements Sensors
 - 2.A.42 Sphygmomanometers
 - 2.A.43 Holographic Devices
 - 2.A.44 High Temperature Viewing Device
 - 2.A.45 Magnetostatic Devices
 - 2.A.46 Optical Monitoring Probes (Type Unspecified)
 - 2.A.47 Pressure Monitoring Probes
 - 2.A.47-1 Thermocouple Gauge
 - 2.A.48 Temperature Monitoring Probes
 - 2.A.49 Spacecraft Plasma Monitoring Probes (Type Unspecified)
 - 2.A.50 Power Monitoring Devices
 - 2.A.50-1 Transmitted Microwave Power Monitor
 - 2.A.50-2 Reflected Microwave Power Monitor
 - 2.A.51 VSWR Measuring Equipment
 - 2.A.52 Attitude Measuring Equipment
 - 2.A.53 Accelerometers
 - 2.A.54 Head Proximity Device

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.A Observation Equipment (Continued)
- 2.A.55 Electrocardiographs
- 2.A.55-1 Vectorcardiographs
- 2.A.56 Electroanalytical Apparatus
- 2.A.57 Cardiotachometers

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.B Control/Display Equipment
- 2.B.01 Control/Display Equipment - Astronomy
- 2.B.01-1 C/D Console, 0.9 M. Narrow Field UV Telescope
- 2.B.01-2 C/D Console, Wide Field UV Telescope
- 2.B.01-3 Instrument Power Distribution Controls and Displays
- 2.B.01-4 Spectrometer Operating Controls and Displays
- 2.B.01-5 Telescope Operation Controls and Displays
- 2.B.01-6 Telescope Deployment Controls and Displays
- 2.B.01-7 Automatic Film Changing System Controls and Displays
- 2.B.02 Control/Display Equipment - Physics
- 2.B.02-1 Single Sweep Oscilloscope Controls and Displays
- 2.B.02-2 Instrument Power Distribution Controls and Displays
- 2.B.02-3 Spectrometer Operating Controls and Displays
- 2.B.02-4 Gas-Surface Interaction Controls and Displays
- 2.B.02-5 Telescope Operation Controls and Displays
- 2.B.02-6 Telescope Deployment Controls and Displays
- 2.B.02-7 SITOS Operation Controls and Displays
- 2.B.02-8 Zero-G Combustion Controls and Displays
- 2.B.02-9 Chemical Laser Controls and Displays
- 2.B.02-10 Physics Subsatellite Controls and Displays
- 2.B.02-11 Electron Probe Controls and Displays
- 2.B.02-12 Photometer Controls and Displays
- 2.B.02-13 Gas Reaction Data Acquisition Displays
- 2.B.02-14 Canister Release Controls
- 2.B.03 Control/Display Equipment - Comm/Nav
- 2.B.03-1 Laser Communication Control/Display Equipment
- 2.B.03-2 Subsatellite Control/Display Equipment
- 2.B.03-3 Millimeter Wave R/T Control/Display Equipment
- 2.B.03-4 ELT Transponder Control/Display Equipment
- 2.B.03-5 Satellite Navigation Control/Display Equipment
- 2.B.03-6 Laser Radar Control/Display Equipment
- 2.B.03-7 Autonomous Navigation Control/Display Equipment
- 2.B.03-8 Plasma Propagation Control/Display Equipment
- 2.B.03-9 Transmitter Breakdown Test Control/Display Equipment
- 2.B.03-10 Multipath Measurements Control/Display Equipment
- 2.B.04 Control/Display Equipment - Earth Observations
- 2.B.04-1 Cloud Chamber Controls and Displays
- 2.B.04-2 Scatterometer-Radiometer Panel
- 2.B.04-2.1 Scatterometer On/Off
- 2.B.04-2.2 Radiometer On/Off
- 2.B.04-2.3 SR Scan Mode Selector (1-8)
- 2.B.04-2.4 Filter Selector (1-8)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXEPRIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.B Control/Display Equipment (Continued)
- 2.B.04 Control/Display Equipment - Earth Observations (Continued)
- 2.B.04-2 Scatterometer-Radiometer Panel (Continued)
- 2.B.04-2.5 Altimeter On/Off
- 2.B.04-2.6 RIB/ALT Gage
- 2.B.04-2.7 ALT Range Selector (1-8)
- 2.B.04-3 Microwave Radiometer Panel
- 2.B.04-3.1 Power On/Off
- 2.B.04-3.2 3M Ant. On/Off
- 2.B.04-3.3 9M Ant. On/Off
- 2.B.04-3.4 3M Ant. Band Selector (1-8)
- 2.B.04-3.5 9M Ant. Band Selector (1-8)
- 2.B.04-3.6 Antenna Pointing (3M/9M)
- 2.B.04-3.7 Temperature Gage (0 - 100°C)
- 2.B.04-3.8 Ant. Temp. Sens. (3M/9M)
- 2.B.04-4 Passive Microwave Scanner Panel
- 2.B.04-4.1 Power On/Off
- 2.B.04-4.2 Cal. Test/Ctr. Test
- 2.B.04-4.3 Frequency Selector (1-8)
- 2.B.04-4.4 MIN Crt. Pwr. On/Off
- 2.B.04-4.5 Brightness Control
- 2.B.04-4.6 Crt. Monitor
- 2.B.04-4.7 Focus Control
- 2.B.04-5 Stellar Camera Panel
- 2.B.04-5.1 Stel. Camr. On/Off
- 2.B.04-5.2 Camr. Selector (1-8)
- 2.B.04-5.3 Spectral Range Adj. (1-8)
- 2.B.04-5.4 Stel. Camr. Frame Rate (1-8)
- 2.B.04-5.5 Ready/Operate Indicator Light
- 2.B.04-5.6 Start/Stop
- 2.B.04-5.7 Frames Remaining Counter
- 2.B.04-6 Metric Camera Panel
- 2.B.04-6.1 Power On/Off
- 2.B.04-6.2 Met. Camr. On/Off
- 2.B.04-6.3 Spectral Range Adj. (1-8)
- 2.B.04-6.4 Met. Camr. Frame Rate (1-8)
- 2.B.04-6.5 Ready/Operate Indicator Light
- 2.B.04-6.6 Start/Stop
- 2.B.04-6.7 Frames Remaining Counter
- 2.B.04-7 Internal Pointing/Alignment Panel
- 2.B.04-7.1 Experiment Align. Selector 1 (1-8)
- 2.B.04-7.2 Alignment Controller 1 (Pitch/Yaw)
- 2.B.04-7.3 Experiment Align. Selector 2 (1-8)
- 2.B.04-7.4 Alignment Controller 2 (Pitch/Yaw)
- 2.B.04-7.5 Monitor 1
- 2.B.04-7.6 Monitor 2

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
 - 2.B Control/Display Equipment (Continued)
 - 2.B.04 Control/Display Equipment - Earth Observations (Continued)
 - 2.B.04-8 Sferics Detector C/D Panel
 - 2.B.04-8.1 MN Pwr. On/Off
 - 2.B.04-8.2 Frequency Indicator
 - 2.B.04-8.3 Amp Gain (1-8)
 - 2.B.04-8.4 Band Pass Selector (1-8)
 - 2.B.04-8.5 Beam Width Selector (1-8)
 - 2.B.04-9 Absorption Spectrometer C/D Panel
 - 2.B.04-9.1 Power On/Off
 - 2.B.04-9.2 Cal. Test/Ctr. Test
 - 2.B.04-9.3 WLTH Selector (ST/LG)
 - 2.B.04-9.4 ST/LG Indicator Light
 - 2.B.04-9.5 Spec. Filt. Selector (1-8)
 - 2.B.04-9.6 Data Recorder On/Off
 - 2.B.04-9.7 Recorder Drive Selector (PB/Rec)
 - 2.B.04-9.8 PB/Rec Indicator Light
 - 2.B.04-9.9 Absorption Energy End Counter
 - 2.B.04-10 Multispectral Spectrometer C&D Panel
 - 2.B.04-10.1 Power On/Off
 - 2.B.04-10.2 Img. Sys. (ENA/INH)
 - 2.B.04-10.3 Spectral Band Selector (1-8)
 - 2.B.04-10.4 Temperature Selector
 - 2.B.04-10.5 Temperature Gage (-100 to -100°F)
 - 2.B.04-11 Multispectral Radiometer C/D Panel
 - 2.B.04-11.1 Power On/Off
 - 2.B.04-11.2 RF Band Selector (1-8)
 - 2.B.04-11.3 Search Angle Selector (1-8)
 - 2.B.04-11.4 Frames Remaining Counter
 - 2.B.04-11.5 Vid. Trk. (ENA/INH)
 - 2.B.04-12 Multispectral Camera C/D Panel
 - 2.B.04-12.1 Camera Power On/Off
 - 2.B.04-12.2 Filter Selector (1-8)
 - 2.B.04-12.3 Filter Confirm Light
 - 2.B.04-12.4 Exposure Time Selector (1-8)
 - 2.B.04-12.5 Frame Rate Selector (1-8)
 - 2.B.04-12.6 Ready/Operate Light
 - 2.B.04-12.7 Start/Stop
 - 2.B.04-12.8 Frames Remaining Counter
 - 2.B.04-13 Multispectral Camera TV C/D Panel
 - 2.B.04-13.1 Power On/Off
 - 2.B.04-13.2 Record Pwr. On/Off
 - 2.B.04-13.3 Slit Focus Adj.
 - 2.B.04-13.4 Collim. Adj.
 - 2.B.04-13.5 Line Scan Speed Adj. (1-8)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.B Control/Display Equipment (Continued)
- 2.B.04 Control/Display Equipment - Earth Observations (Continued)
- 2.B.04-13 Multispectral Camera TV C/D Panel (Continued)
- 2.B.04-13.6 Band Width Selector (1-8)
- 2.B.04-13.7 Vid. Recorder On/Off
- 2.B.04-13.8 Vid. Recorder Ft Remaining Counter
- 2.B.04-14 Multispectral Scanner C/D Panel
- 2.B.04-14.1 Power On/Off
- 2.B.04-14.2 Mode Selector (1-8)
- 2.B.04-14.3 Align. Pos. Sel. (1-8)
- 2.B.04-14.4 Cal. Test/Ctr. Test
- 2.B.04-14.5 Data Rec'dr On/Off
- 2.B.04-14.6 Data Store/Erase
- 2.B.04-14.7 Store/Erase Indicator Light
- 2.B.04-14.8 Cal. Source Inten. Counter
- 2.B.04-14.9 Channel Selector (Pri/Sec)
- 2.B.04-14.10 Cryo. Pump (Pri/Sec)
- 2.B.04-14.11 Cryogenic Pressure Gage (0 - 100)/Temp. Gage (-20 to +60)
- 2.B.04-15 Microwave Radar C/D Panel
- 2.B.04-15.1 Power On/Off
- 2.B.04-15.2 Ant. Motor Drive On/Off
- 2.B.04-15.3 Ant. Deploy/Retract
- 2.B.04-15.4 Ant. Dir. Sel. (1-8)
- 2.B.04-15.5 Data Recv'd (ENA/INH)
- 2.B.04-15.6 Data Tape Remaining Counter
- 2.B.04-16 Spectral Polarimeter C/D Panel
- 2.B.04-16.1 Power On/Off
- 2.B.04-16.2 Tele. Bias. In/Out
- 2.B.04-16.3 Camera ENA/INH
- 2.B.04-16.4 Data Rec'dr On/Off
- 2.B.04-16.5 Recorder Sel. (PB/Rec)
- 2.B.04-16.6 PB/Rec Indicator Light
- 2.B.04-17 Aeronomy Spectrometer C/D Panel
- 2.B.04-17.1 Interf. On/Off
- 2.B.04-17.2 Spectrom. On/Off
- 2.B.04-17.3 Cal. Test/Ctr. Test
- 2.B.04-17.4 Tele. Bias In/Out
- 2.B.04-17.5 Data Recdr. On/Off
- 2.B.04-17.6 Rec'dr Sel. (PB/Rec)
- 2.B.04-17.7 PB/Rec Indicator Light
- 2.B.04-18 Observation Telescope C/D Panel
- 2.B.04-18.1 Power On/Off
- 2.B.04-18.2 Collin. Act/Deact
- 2.B.04-18.3 Camr. On/Off (DAC)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.B Control/Display Equipment (Continued)
- 2.B.04 Control/Display Equipment - Earth Observations (Continued)
- 2.B.04-18 Observation Telescope C/D Panel (Continued)
- 2.B.04-18.4 Frame Rate (Fast/Slow) (DAC)
- 2.B.04-18.5 Tape Rec'dr On/Off
- 2.B.04-18.6 Rec'dr PB/Rec
- 2.B.04-18.7 PB/Rec Light
- 2.B.04-18.8 Frames Remaining Counter (DAC)

- 2.B.05 Control/Display Equipment - Life Sciences
- 2.B.05-1 Readouts and gages (Undefined)
- 2.B.05-2 Heart Rate Monitor
- 2.B.05-3 Medical Research Control/Display Console
- 2.B.05-4 Life Support Subsystem Test Unit (LSSTU)
- 2.B.05-5 Life Sciences Experiment Support Unit

- 2.B.06 Control/Display Equipment - Materials Science
- 2.B.06-1 Process Control Computer
- 2.B.06-2 Instrumentation and Control Center
- 2.B.06-3 Biological Enclosure C/D Panel
- 2.B.06-3.1 Pwr On/Off
- 2.B.06-3.2 UV Lamp On/Off
- 2.B.06-3.3 UV Lamp Indicator Light
- 2.B.06-3.4 Shower On/Off
- 2.B.06-3.5 Shower Indicator Light
- 2.B.06-3.6 Start/Stop Switch
- 2.B.06-3.7 Start/Stop Indicator Light
- 2.B.06-4 Controlled Atmosphere Chamber C/D Panel
- 2.B.06-4.1 Pwr On/Off
- 2.B.06-4.2 Ion Bomb (On/Off)
- 2.B.06-4.3 Ion Bomb Indicator Light
- 2.B.06-4.4 Ion Pump Set Switch
- 2.B.06-4.5 Ion Pump Indicator Light
- 2.B.06-4.6 Sub Pump Set Switch
- 2.B.06-4.7 Sub Pump Indicator Light
- 2.B.06-4.8 Start/Stop Switch
- 2.B.06-4.9 Start/Stop Indicator Light
- 2.B.06-5 General Purpose Lab Installation C/D Panel
- 2.B.06-5.1 Pwr On/Off
- 2.B.06-5.2 Vac Pull On/Off
- 2.B.06-5.3 Power Gage (0 - 100)
- 2.B.06-5.4 Vac Gage (-20 to +60)
- 2.B.06-5.5 Gas #1 On/Off
- 2.B.06-5.6 Gas #1 Supply Status Gage (-100 to +100)
- 2.B.06-5.7 Gas #2 On/Off

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
 - 2.B Control/Display Equipment (Continued)
 - 2.B.06 Control/Display Equipment - Materials Sciences (Continued)
 - 2.B.06-5 General Purpose Lab Installation C/D Panel (Continued)
 - 2.B.06-5.8 Gas #2 Supply Status Gage (-80 to +80)
 - 2.B.06-5.9 Gas #3 On/Off
 - 2.B.06-5.10 Gas #3 Supply Status Gage (0 - 100)
 - 2.B.06-5.11 Gas #4 On/Off
 - 2.B.06-5.12 Gas #4 Supply Status Gage (-20 to +60)
 - 2.B.06-6 Environmental Chamber A/B C&D Panel
 - 2.B.06-6.1 Chamber Select Switch (A/B)
 - 2.B.06-6.2 Chamber Select Switch Indicator Light
 - 2.B.06-6.3 Temperature Gage (0 - 100°C)
 - 2.B.06-6.4 Start/Stop Switch
 - 2.B.06-6.5 Start/Stop Indicator Light
 - 2.B.06-6.6 Pwr On/Off
 - 2.B.06-6.7 Temperature Control Knob
 - 2.B.06-7 Atmosphere Supply and Control System C&D Panel
 - 2.B.06-7.1 Pwr On/Off
 - 2.B.06-7.2 Gas Intake Valve #1 (Open/Close)
 - 2.B.06-7.3 Gas Intake Valve #1 Indicator Light
 - 2.B.06-7.4 Gas Intake Valve #2 (Open/Close)
 - 2.B.06-7.5 Gas Intake Valve #2 Indicator Light
 - 2.B.06-7.6 Gas Intake Valve #3 (Open/Close)
 - 2.B.06-7.7 Gas Intake Valve #3 Indicator Light
 - 2.B.06-7.8 Gas Intake Valve #4 (Open/Close)
 - 2.B.06-7.9 Gas Intake Valve #4 Indicator Light
 - 2.B.06-7.10 Vac Pull Switch
 - 2.B.06-7.11 Vac Pull Indicator Light
 - 2.B.06-7.12 Gas Mix Flow Switch (He) (N₂)
 - 2.B.06-7.13 He Indicator Light
 - 2.B.06-7.14 N₂ Indicator Light
 - 2.B.06-7.15 Temperature Gage (-100 to -100°C)
 - 2.B.06-7.16 Start/Stop Switch
 - 2.B.06-7.17 Start/Stop Indicator Light
 - 2.B.06-8 Sensor Selection and Display Panel
 - 2.B.06-8.1 Pwr On/Off
 - 2.B.06-8.2 Sensor 1 On/Off Switch
 - 2.B.06-8.3 Sensor 1 Indicator Light
 - 2.B.06-8.4 Sensor 1 Select Switch (1-8)
 - 2.B.06-8.5 Sensor 1 Digital Counter
 - 2.B.06-8.6 Sensor 2 On/Off Switch
 - 2.B.06-8.7 Sensor 2 Indicator Light
 - 2.B.06-8.8 Sensor 2 Select Switch (1-8)
 - 2.B.06-8.9 Sensor 2 Digital Counter

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.B Control/Display Equipment (Continued)
- 2.B.06 Control/Display Equipment - Materials Sciences (Continued)
- 2.B.06-8 Sensor Selection and Display Panel (Continued)
- 2.B.06-8.10 Sensor 3 On/Off Switch
- 2.B.06-8.11 Sensor 3 Indicator Light
- 2.B.06-8.12 Sensor 3 Digital Counter
- 2.B.06-9 Power Conditioning and Distribution/Circuit Breakers C/D Panel
- 2.B.06-9.1 Start/Stop Switch
- 2.B.06-9.2 Start/Stop Indicator Light
- 2.B.06-9.3 AC/DC Switch
- 2.B.06-9.4 AC/DC Indicator Light
- 2.B.06-9.5 Battery Digital Counter
- 2.B.06-9.6 Select Switch (1-8)
- 2.B.06-9.7 "Undefined Controls"
- 2.B.06-10 Resistance Heated Furnace C/D Panel
- 2.B.06-10.1 On/Off
- 2.B.06-10.2 On/Off Indicator Light
- 2.B.06-10.3 Temperature Control Knob
- 2.B.06-10.4 Temperature Gage (-80 to +80°C)
- 2.B.06-11 Heating and Positioning Coils C/D Panel
- 2.B.06-11.1 Pwr On/Off
- 2.B.06-11.2 Start/Stop Switch
- 2.B.06-11.3 Start/Stop Indicator Light
- 2.B.06-11.4 Power Level Control Knob
- 2.B.06-11.5 Power Level Gage (0 - 100)
- 2.B.06-11.6 Cooling Switch (Max/Min)
- 2.B.06-11.7 Cooling Gage (-20 to +60)
- 2.B.06-12 Dispersion Control System C/D Panel
- 2.B.06-12.1 Pwr On/Off
- 2.B.06-12.2 Start/Stop Switch
- 2.B.06-12.3 Start/Stop Indicator Light
- 2.B.06-13 Mixing Unit - Liquid/Liquid, Liquid/Solid C/D Panel
- 2.B.06-13.1 Nozzle Selector (1-8)
- 2.B.06-13.2 Nozzle Select Indicator Lights
- 2.B.06-13.3 Dispersion Selector (1-8)
- 2.B.06-13.4 Dispersion Select Indicator Lights
- 2.B.06-13.5 Pwr On/Off
- 2.B.06-13.6 Vibrator A On/Off
- 2.B.06-13.7 Vibrator B On/Off
- 2.B.06-13.8 Vibrator A Gage (-100 to +100)
- 2.B.06-13.9 Vibrator B Gage (-80 to +80)
- 2.B.06-13.10 Transducer A On/Off
- 2.B.06-13.11 Transducer B On/Off
- 2.B.06-13.12 Transducer A Indicator Light
- 2.B.06-13.13 Transducer B Indicator Light

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.B Control/Display Equipment (Continued)
- 2.B.06 Control/Display Equipment - Materials Sciences (Continued)
- 2.B.06-13 Mixing Unit - Liquid/Liquid, Liquid/Solid C/D Panel
- 2.B.06-13.14 Feed A On/Off
- 2.B.06-13.15 Feed B On/Off
- 2.B.06-13.16 Feed A Indicator Light
- 2.B.06-13.17 Feed B Indicator Light
- 2.B.06-14 Remove Measuring Device C/D Panel
- 2.B.06-14.1 Pwr On/Off
- 2.B.06-14.2 Start/Stop Switch
- 2.B.06-14.3 Start/Stop Indicator Light
- 2.B.06-15 Mixing Unit - Liquid Gas, C/D Panel
- 2.B.06-15.1 Pwr On/Off
- 2.B.06-15.2 Mix Nozzle Selector (1-6)
- 2.B.06-15.3 Mix Nozzle Select Indicator Light
- 2.B.06-15.4 Valve Pres. Selector (1-6)
- 2.B.06-15.5 Valve Pres. Select Indicator Light
- 2.B.06-15.6 Gas Supply Switch (On/Off)
- 2.B.06-15.7 Gas Supply Indicator Light
- 2.B.06-15.8 Liquid Supply Switch (On/Off)
- 2.B.06-15.9 Liquid Supply Indicator Light
- 2.B.06-15.10 Dispersion Selector (1-8)
- 2.B.06-15.11 Dispersion Percent Gage (0 - 100)
- 2.B.06-15.12 Temperature Selector (1-8)
- 2.B.06-15.13 Temperature Gage (-20 to +60°C)
- 2.B.06-16 Vibrator C/D Panel
- 2.B.06-16.1 Small Mech. Pwr On/Off
- 2.B.06-16.2 Small Mech. Start/Stop Switch
- 2.B.06-16.3 Small Mech. Start/Stop Indicator Light
- 2.B.06-16.4 Small Variable Freq. Select Pwr On/Off
- 2.B.06-16.5 Small Variable Freq. Select Start/Stop Switch
- 2.B.06-16.6 Small Variable Freq. Select Start/Stop Indicator Light
- 2.B.06-16.7 Small Variable Freq. Selector (1-8)
- 2.B.06-16.8 Small Variable Freq. Select Digital Counter
- 2.B.06-16.9 Ultrasonic Freq. Select Pwr (On/Off)
- 2.B.06-16.10 Ultrasonic Freq. Select Start/Stop Switch
- 2.B.06-16.11 Ultrasonic Freq. Select Start/Stop Indicator Light
- 2.B.06-16.12 Ultrasonic Freq. Selector (1-8)
- 2.B.06-16.13 Ultrasonic Freq. Select Digital Counter
- 2.B.06-17 Variable High freq. Power Unit C/D Panel
- 2.B.06-17.1 Pwr On/Off
- 2.B.06-17.2 Frequency Selector (1 - 8)
- 2.B.06-17.3 Frequency Selector Indicator Light
- 2.B.06-17.4 Power Switch (High/Low)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.B Control/Display Equipment (Continued)
- 2.B.06 Control/Display Equipment - Materials Sciences (Continued)
- 2.B.06-17 Variable High Freq. Power Unit C/D Panel (Continued)
- 2.B.06-17.5 Power Switch Indicator Light
- 2.B.06-17.6 Mode Switch (A/B)
- 2.B.06-17.7 Mode Switch Indicator Light
- 2.B.06-17.8 Level (1/2)
- 2.B.06-17.9 Level Indicator Light
- 2.B.06-17.10 Outlet/Power Gage (-20 to +60)
- 2.B.06-18 Microscope Stage Attachment C/D Panel
- 2.B.06-18.1 Heating (On/Off)
- 2.B.06-18.2 Heating Selector (1 - 6)
- 2.B.06-18.3 Cooling (On/Off)
- 2.B.06-18.4 Cooling Selector (1 - 6)
- 2.B.06-18.5 Temperature Gage (0 - 100°C)
- 2.B.06-19 Continuous Electrophoretic Column C/D Panel
- 2.B.06-20 Buffer Recovery/Waste Disposal C/D Panel
- 2.B.06-21 Gas Elimination/Cooling System C/D Panel
- 2.B.06-22 Controlled Atmosphere Fluid Storage C/D Panel
- 2.B.06-23 Lyophilization C/D Panel
- 2.B.06-24 Czochralski Crystal Puller C/D Panel
- 2.B.06-25 Silicate Melt Susceptor C/D Panel
- 2.B.06-26 Seed Injector C/D Panel (Hollow Bodies Deployment System C/D Panel)
- 2.B.06-27 Atmosphere Analysis unit C/D Panel
- 2.B.06-28 High Temperature Viewing Device C/D Panel
- 2.B.06-29 High Temperature Calorimeter C/D Panel
- 2.B.06-30 Internal Friction Measuring Device C/D Panel
- 2.B.06-31 Chill System C/D Panel
- 2.B.06-32 Liquid Sphere Deployment System C/D Panel
- 2.B.06-33 Slip Cast Injection System C/D Panel
- 2.B.06-34 Model Zone Refiner C/D Panel
- 2.B.06-35 Zone Melter C/D Panel
- 2.B.06-36 Peltier Heater/Holder C/D Panel
- 2.B.07 Control/Display Equipment - Technology
- 2.B.07-1 Teleoperator Control Station
- 2.B.08 Manual Pointing Control Equipment
- 2.B.09 Video Display Center - Payload Support

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.C Experiment Materials
- 2.C.01 Maps
- 2.C.01-1 Topographic Maps of Earth Surface
- 2.C.02 Rotational Testing Devices and Associated Equipment
- 2.C.02-1 Rotating Litter Chair
- 2.C.02-2 Otolith Test Goggles
- 2.C.02-3 Magnetic Pointer ("Rod and Sphere Apparatus")
- 2.C.02-4 Reference Sphere ("Rod and Sphere Apparatus")
- 2.C.03 Physiological Test Devices
- 2.C.03-1 Lower Body Negative Pressure (LBNP) Device
- 2.C.04 Chemicals and Biologicals
- 2.C.04-1 PAH (Para-Aminohippuric Acid)
- 2.C.04-2 ADH
- 2.C.04-3 Agar Nutrient Culture
- 2.C.04-4 Bacterial Colonies (Species Not Defined)
- 2.C.04-5 Solvents
- 2.C.04-6 Buffer Solutions
- 2.C.04-7 Biological Materials (for Electrophoretic Separation and Lyophilization)
- 2.C.04-8 Biological Reagents
- 2.C.04-9 Enzymes
- 2.C.04-10 Dopants for Crystal Growth
- 2.C.05 Body Fluids and Wastes
- 2.C.05-1 Urine
- 2.C.05-2 Feces
- 2.C.05-3 Blood
- 2.C.05-4 Saliva
- 2.C.06 Laser Fuels and Oxidizer
- 2.C.07 Chemical Lasers
- 2.C.08 Food and Drink for Consumption
- 2.C.09 Fecal Dye Markers
- 2.C.10 Teleoperator Spacecraft
- 2.C.10-1 Video/Illumination System
- 2.C.10-2 Communication System

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.C Experiment Materials (Continued)
- 2.C.11 Airlock Task Board
 - 2.C.11-1 Thermal Insulation
 - 2.C.11-2 Film Pack
 - 2.C.11-3 Thruster Assembly
 - 2.C.11-4 Satellite Skin Panel
 - 2.C.11-5 Electrical Connector
 - 2.C.11-6 Fuel Transfer Lines
 - 2.C.11-7 Adjustment/Alignment Stops
 - 2.C.11-8 Structural Fasteners
 - 2.C.11-9 Jury Structure
 - 2.C.11-10 Electronic Modules
 - 2.C.11-11 Fluid Valves
- 2.C.12 Docking Adapter
- 2.C.13 Spare Parts and Tools
- 2.C.14 Metal Matrix Composite Materials
 - 2.C.14-1 Fiber-Reinforced Composites
 - 2.C.14-2 Particle-Dispersed Composites
 - 2.C.14-3 Cemented Compacts
 - 2.C.14-4 Controlled Eutectic Structures
 - 2.C.14-5 Controlled Monotectic Structures
 - 2.C.14-6 Metal Foams
 - 2.C.14-7 Controlled Density Metals
- 2.C.15 Maintainable Attitude Control System
- 2.C.16 Flame Chemistry Fuels (Gases) and Oxidizers
- 2.C.17 Navigation Code Generator
- 2.C.18 Precision Clock
- 2.C.19 Inertial Navigation Sensor
- 2.C.20 Microwave Breakdown Test Structures
 - 2.C.20-1 Microwave Antenna
 - 2.C.20-2 Microwave Antenna Feed
- 2.C.21 Microwave Radiation Energy
- 2.C.22 Reentry Vehicle Probes
- 2.C.23 Basic Metals

TASK DEPENDENCY REFERENCE LIST
- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.C Experiment Materials (Continued)
- 2.C.24 Immiscible Liquid Systems
- 2.C.25 Crystal Growth Materials and Samples
- 2.C.26 Glass Preparation Materials and Samples
- 2.C.27 Fluid Materials and Samples
- 2.C.28 Human Subjects
- 2.C.29 Atmosphere Supply and Control Systems
- 2.C.29-1 Two Gas Control Unit Test Specimen (Type Unspecified)
- 2.C.29-2 Multigas Mass Spectrometer Sensor and Control
- 2.C.30 EVA Suits
- 2.C.31 Biopacks
- 2.C.32 Manikins
- 2.C.33 EVA Test Assembly (Contents Unspecified)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.D Materials Control Equipment (Continued)
- 2.D.01 Gas Release Devices
- 2.D.01-1 NH₃ Gas Canister
- 2.D.01-2 ICN¹⁶ Gas Canister
- 2.D.02 Cloud Chamber
- 2.D.03 Gas Storage Devices
- 2.D.04 Gas Mixing Devices
- 2.D.05 Injection and Withdrawal Instruments
- 2.D.05-1 Hypodermic Syringes
- 2.D.05-2 Ampoule
- 2.D.05-3 Sample Syringe
- 2.D.06 Zero-G Combustion Device
- 2.D.06-1 Various Size Gas Tubes
- 2.D.07 Laser Fuel and Oxidizer Containers
- 2.D.08 Food and Beverage Measuring Equipment
- 2.D.09 Canister Deployment Mechanisms
- 2.D.10 Biological Samples Containers
- 2.D.10-1 Sample Storage Containers
- 2.D.10-2 Centrifuge Tubes
- 2.D.11 Teleoperator Deployment/Retrieval Mechanism
- 2.D.12 Incubators
- 2.D.13 Environmental Chambers
- 2.D.13-1 Environmental Chamber "A" - Passive Cooling
- 2.D.13-2 Environmental Chamber "B" - Passive Cooling
- 2.D.13-3 Environmental Chamber "C" - Active Cooling
- 2.D.13-4 Controlled Atmosphere Chamber
- 2.D.14 Liquid Metal Supply System
- 2.D.15 Atmosphere Supply and Control System (For Environmental Chambers)
- 2.D.16 Subsatellite Storage Point/Container

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.D Materials Control Equipment (Continued)
- 2.D.17 Mold Injection System
- 2.D.18 Dispersion Control System
- 2.D.19 Materials Forming Equipment
- 2.D.19-1 Molds
- 2.D.19-2 Cavities
- 2.D.19-3 Crucibles
- 2.D.19-4 Crystal Growth Tubes
- 2.D.20 Miscellaneous Internal Attachments (Materials Science)
- 2.D.21 Mixing Units
- 2.D.21-1 Liquid/Solid Mixing Unit
- 2.D.21-2 Liquid/Liquid Mixing Unit
- 2.D.21-3 Liquid/Gas Mixing Unit
- 2.D.21-4 Manual Mixing Equipment
- 2.D.22 Vibrator
- 2.D.23 Freezers
- 2.D.24 Furnaces
- 2.D.24-1 Resistance Heated Furnace (1600°C)
- 2.D.24-2 Inert/Vacuum Furnace (2600°C)
- 2.D.24-3 Oxygen Furnace (3200°C)
- 2.D.25 Open Materials and Fluid Storage Containers
- 2.D.26 Water Recovery System/Components
- 2.D.26-1 Specimen Unit
- 2.D.26-2 Chemical/Microbial Analysis Equipment
- 2.D.27 Materials Analysis Equipment
- 2.D.27-1 Metallographs
- 2.D.27-2 Cutoff Saws
- 2.D.27-3 Polishers
- 2.D.27-4 X-Ray Diffraction Unit
- 2.D.27-5 pH Meter
- 2.D.27-6 Volumetric Displacement Apparatus
- 2.D.27-7 Zero-G Balance

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.D Materials Control Equipment (Continued)
- 2.D.28 Biomedical Fluid Transfer Equipment
- 2.D.29 Zone Melter
- 2.D.30 Chemical Storage and Release Devices
- 2.D.31 Clinical Centrifuges
- 2.D.32 Heating and Positioning Coil Sets
- 2.D.33 Plasma Electron Beam Unit
- 2.D.34 Continuous Atmosphere Analysis Apparatus
- 2.D.35 Controlled Atmosphere Fluids Storage Equipment
- 2.D.36 Biological Enclosure
- 2.D.37 Electrophoretic Columns
- 2.D.37-1 Stationary Electrophoretic Column
- 2.D.37-2 Continuous Electrophoretic Column
- 2.D.38 Lower Body Negative Pressure (LBNP) Device
- 2.D.39 Buffer Recovery/Waste Disposal System
- 2.D.40 Gas Elimination/Cooling System
- 2.D.41 Food Preparation/Storage/Feeding Equipment
- 2.D.42 (Not Assigned)
- 2.D.43 Lyophilization Apparatus
- 2.D.43-1 Basic Lyophilization Unit
- 2.D.43-2 Rack for Sample Vials
- 2.D.43-3 Sample Vials
- 2.D.43-4 Heat Pumps
- 2.D.43-5 Sample Vial Stoppers (Mechanically Actuated)
- 2.D.44 Biologicals Measuring Device
- 2.D.45 Susceptor for Silicate Melts
- 2.D.46 Liquid Sphere Deployment System

TASK DEPENDENCY REFERENCE LIST
- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.D Materials Control Equipment (Continued)
- 2.D.47 Hollow Bodies Deployment System
- 2.D.48 Membrane Drawing Tool
- 2.D.49 Czochralski Crystal Puller
- 2.D.50 Slip Cast Injection System
- 2.D.51 Model Zone Refiner
- 2.D.52 VHF Power Unit
- 2.D.53 Chill System
- 2.D.54 Microwave Transmitter, 10 kw
- 2.D.55 Waveform Modulators
- 2.D.56 Microscope Stage Heating/Cooling Device
- 2.D.57 Floating Zone Test Cell
- 2.D.58 Chemicals and Biologicals Transfer Equipment
- 2.D.59 Peltier Heater/Holder Device

- 2.E Accessories
- 2.E.01 Cables and Connectors
- 2.E.02 Star Trackers
- 2.E.02-1 Guide Star Tracker
- 2.E.02-2 Star Tracker/Inertial Reference Assembly
- 2.E.02-3 Star Field Lock on Unit
- 2.E.03 Microscopes
- 2.E.04 Electrodes, Biological Data
- 2.E.05 Experiment Equipment Drives
- 2.E.05-1 Roll Drive
- 2.E.05-2 Pitch Drive

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)

2.E Accessories (Continued)

2.E.05 Experiment Equipment Drives (Continued)

2.E.05-3 Yaw Drive

2.E.05-4 Camera Mirror Cell and Focus Drive

2.E.05-5 Secondary Mirror Cell and Focus Drive

2.E.05-6 Collating Mirror Cell and Focus Drive

2.E.05-7 Fine Grating Drive

2.E.05-8 Coarse Grating Drive

2.E.05-9 Light Shade Drive

2.E.05-10 Filter Slide Drive

2.E.06 Automatic Film Cassette Replacement System

2.E.07 Battery Charger System

2.E.08 Refueling System

2.E.09 X-Ray Shielded Holding Unit

2.E.10 Timing Devices

2.E.10-1 Stop Watches

2.E.10-2 Electric/Electronic Timer

2.F Experiment Records and Data

2.F.01 Film Records

2.F.01-1 Earth Survey Film Data

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2.F.02 Hard Copy Records

2.F.02-1 Questionnaires (Record Keeping Materials)

2.F.02-2 Response Matrix Forms (Record Keeping Materials)

2.F.02-3 Instrument Mode Records

2.F.02-4 Photographs

2.F.02-5 Strip Charts

2.F.03 Tape Recordings

2.F.03-1 Audio Recordings

2.F.03-2 Video Recordings

2.F.03-3 Digital Recordings

2.F.04 Specimen and Samples

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 2. EXPERIMENT EQUIPMENT AND MATERIALS (Continued)
- 2.G Integral Spacecraft Systems
- 2.G.01 RAM Mobility Unit
 - 2.G.01-1 Portable Metabolic Rate Analyzer (PMA)
 - 2.G.01-2 Portable Acceleration Sensors
 - 2.G.01-3 Elapsed Time Timer
 - 2.G.01-4 Selected Locomotion and Restraint Devices
 - 2.G.01-5 Impact Force Recorder
- 2.G.02 RAM Airlock/EVA Capability Unit
 - 2.G.02-1 Airlocks
 - 2.G.02-2 Pressure Suits
 - 2.G.02-3 EVA Viewing Ports
 - 2.G.02-4 Tether Control Units
 - 2.G.02-5 Unspecified Communications Systems
- 2.G.03 RAM Visual Records Unit
 - 2.G.03-1 Motion Picture Equipment
 - 2.G.03-2 Video Tape Equipment
- 2.G.04 Reaction Control System
 - 2.G.04-1 Control Valve
- 2.G.05 Waste Management System

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

3. OBJECT OR AREA UNDER INVESTIGATION

3.A Solar Phenomena

3.B Stellar Phenomena

3.B.01 Ultraviolet (UV) Emissions

3.B.01-1 Galaxies

3.B.01-2 Stellar Nebulae

3.B.01-3 Planetary Nebulae

3.B.01-4 Star Clusters

3.B.01-5 Quasars

3.B.01-6 Novae

3.C Earth Surface

3.C.01 Topography

3.C.02 Near-Earth Atmosphere

3.C.02-1 (Not Used)

3.C.03-2 Air Pollution

3.C.03 Inland Waterways

3.C.03-1 (Not Used)

3.C.03-2 Water Pollution

3.C.04 Oceans

3.C.04-1 Marine Vegetation

3.C.04-2 Water Pollution

3.C.05 Potential Disasters

3.C.05-1 Geological Precursors

3.C.05-2 Meteorological Precursors

3.C.05-3 Artificial Precursors

3.C.05-4 Topographical Precursors

3.C.05-5 Destructive Events as Precursors

3.C.06 Actual Disasters

3.C.06-1 Earthquakes

3.C.06-2 Hurricanes

3.C.06-3 Tornadoes

3.C.06-4 Tidal Waves (Tsunamis)

3.C.06-5 Floods

TASK DEPENDENCY REFERENCE LIST
- NUMERICAL LISTING -

3. OBJECT OR AREA UNDER INVESTIGATION (Continued)

3.C Earth Surface (Continued)

3.C.06 Actual Disasters (Continued)

3.C.06-6 Volcanic Eruptions

3.C.06-7 Forest Fires

3.C.06-8 Range/Grass Fires

3.C.06-9 Landslides (Avalanche)

3.C.06-10 Snowslides (Avalanche)

3.C.06-11 Land Subsidence

3.C.06-12 Drought

3.C.06-13 Blizzards

3.C.07

3.D. Man - Biological and Physiological Aspects

3.D.01 Mineral Balance

3.D.02 Rotational Gravity Effects

3.D.02-1 Semicircular Canals Stimulation Threshold

3.D.02-2 Semicircular Canals Stimulation Susceptibility Symptoms

3.D.02-3 Spatial Localization

3.D.03 Cardioangiologv

3.D.03-1 Cardiovascular Deconditioning

3.D.04 Urology

3.D.04-1 Renal Blood Flow

3.D.05 Vestibular Function

3.D.06 Bone Densitometry

3.D.07 Metabolic Activity

3.D.08 Endocrine Function

3.D.09 Exercise Conditioning

3.D.10 Airborne and Surface Contamination

3.D.11 Man's Immunity, in Vitro Aspects

3.D.12 Bacteriology

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

3. OBJECT OR AREA UNDER INVESTIGATION (Continued)
 3.E Spacecraft (Physical and Structural Factors)

3.F Extravehicular Space Environment
 3.F.01 Molecular Beam Scattering

3.F.02 Gas-Surface Interaction

3.F.03 Gas Reactions

3.G Planetary Studies

3.H Lunar Studies

3.I Processes in Zero Gravity
 3.I.01 Cloud Formation

3.I.02 Combustion Phenomena
 3.I.02-1 Temperature
 3.I.02-2 Pressure
 3.I.02-3 Chemical Composition of Flame
 3.I.02-4 Flame Visible Structure

3.I.03 Chemical Laser Operation

3.I.04 Metal Structure
 3.I.04-1 Fiber Orientation
 3.I.04-2 Particle Distribution
 3.I.04-3 Grain Structure
 3.I.04-4 Liquid-Phase Sintering
 3.I.04-5 Directional Freezing
 3.I.04-6 Monotectic Alloy Mixtures
 3.I.04-7 Gas Bubble Distribution (Metal Foams and Controlled Density)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

3. OBJECT OR AREA UNDER INVESTIGATION (Continued)

3.I Processes in Zero Gravity (Continued)

3.I.04 Metal Structure (Continued)

3.I.04-8 Free-Casting

3.I.04-9 Liquid Dispersions; Slip Casting

3.I.04-10 Liquid Dispersions; Immiscible Liquids

3.I.05 Crystal Structure

3.I.05-1 Growth from Solution

3.I.05-2 Growth from Melts

3.I.05-3 Growth from Vapor

3.I.05-4 Homogeneous Nucleation by Supercooling

3.I.06 Preparation of Glasses

3.I.06-1 Optical Glasses

3.I.06-2 Oxide Composition Glasses

3.I.07 Biological Processing

3.I.07-1 Electrophoretic Separation of Organic Molecules

3.I.08 Convection of Fluids

3.J Process in Vacuum

3.J.01 Lyophilization

3.K Communication Processes and Equipment

3.K.01 Laser Communication

3.K.01-1 Intervehicular Space Communication

3.K.01-2 Space to Ground Communication

3.K.02 Millimeter Wave Sources

3.K.02-1 Intervehicular Space Communication

3.K.02-2 Space to Ground Communication

3.K.03 Surveillance and Search and Rescue

3.K.04 Laser Radar

3.K.05 Microwave Energy Transmitter Breakdown

TASK DEPENDENCY REFERENCE LIST
- NUMERICAL LISTING -

- 3. OBJECT OR AREA UNDER INVESTIGATION (Continued)
- 3.L Navigational Processes and Equipment
- 3.L.01 Navigation Data

- 3.N Life Support and Habitability Systems and Equipment
- 3.N.01 Water Recovery Methods and Components
- 3.N.02 Waste Management Methods and Components
- 3.N.03 Advanced Cooling System Methods and Components
- 3.N.04 Zero-Gravity Whole-Body Shower
- 3.N.05 Advanced Two-Gas Atmosphere Supply and Control Systems
- 3.N.06 Carbon Dioxide Collection Methods and Components
- 3.N.07 Protective Clothing and Advanced Space Suit Assemblies
- 3.N.08 EVA Suit and Biopack
- 3.N.09 Food Storage, Preparation and Feeding Methods
- 3.N.10 Biopack Technology

- 3.O Man - Performance Capability Aspects
- 3.O.01 (Not Assigned)
- 3.O.02 Cargo Handling Capabilities
- 3.O.03 Assembly, Deployment, Maintenance and Repair Capabilities
- 3.O.04 Locomotion and Restraint Capabilities

TASK DEPENDENCY REFERENCE LIST
- NUMERICAL LISTING -

- 4. SUPPORT EQUIPMENT
 - 4.A Communications Equipment
 - 4.A.01 Telemetry
 - 4.A.02 Voice Radio
 - 4.A.03 Vehicle Intercomm
 - 4.A.04 Data Compression (Dump) Equipment
 - 4.A.05 Data Storage Equipment
 - 4.A.06 EVA-Vehicle Intercom Equipment
 - 4.B Data Processing Equipment
 - 4.B.01 Computers
 - 4.B.01-1 Special Purpose Computer, 0.9 M. Narrow Field UV Telescope Experiment
 - 4.B.01-2 General Purpose Computer
 - 4.B.01-3 Telescope Computer (Earth Observations)
 - 4.B.02 Amplifiers
 - 4.B.02-1 Preamplifiers
 - 4.B.02-2 Narrow Pass Band Amplifiers
 - 4.B.03 Phase Shifter
 - 4.B.04 Phase Sensitive Detector
 - 4.B.05 A/D Converter
 - 4.B.06 Null Signal System
 - 4.B.07 Data Encoding Keyboards
 - 4.B.08 Film Developing Processing Equipment
 - 4.B.09 Data Management Unit, Life Sciences FPEs
 - 4.B.10 Line Readers/Scanners

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 4. SUPPORT EQUIPMENT (Continued)
- 4.C Test and Checkout Equipment
- 4.C.01 Calibration Equipment and Materials
- 4.C.01-1 Optical Spectrometer Calibration Lamps
- 4.C.01-2 Mass Spectrometer Calibration Gases
- 4.C.01-3 Gas Chromatograph Calibration Gases
- 4.C.02 Electrical/Electronic Equipment Test Equipment
- 4.C.02-1 Oscilloscopes
- 4.C.02-2 Digital Multimeters
- 4.C.02-3 Function Generators
- 4.C.03 Laser Transmitter/Receiver Test Equipment
- 4.C.04 Radar Transmitter/Receiver Test Equipment
- 4.C.05 Radio Transmitter/Receiver Test Equipment
- 4.C.06 Millimeter Wave Transmitter/Receiver Test Equipment
- 4.C.07 Optical Equipment Test Equipment
- 4.D Miscellaneous Equipment and Materials
- 4.D.01 Equipment Covers and Caps
- 4.D.01-1 Protective Cover, 0.9 M. Narrow Field UV Telescope
- 4.D.01-2 Protective Cap, 0.9 M. Narrow Field UV Telescope Optics
- 4.D.01-3 Protective Cover, 16 Inch Cassegrain Telescope
- 4.D.01-4 Protective Cap, 16 Inch Cassegrain Telescope Optics
- 4.D.01-5 Protective Cap, Star Tracker
- 4.D.01-6 Protective Cap, Field TV Camera
- 4.D.01-7 Protective Cap, Combined Electronic/Backup Film Camera
- 4.D.01-8 Protective Cap, Scanner
- 4.D.01-9 Protective Cap, Radiometer
- 4.D.01-10 Protective Cap, Scatterometer
- 4.D.01-11 Protective Cap, Spectrometer
- 4.D.01-12 Protective Cap, Polarimeter
- 4.D.02 Equipment Launch Restraints and Securing Devices
- 4.D.02-1 Launch Restraints, 0.9 M. Narrow Field UV Telescope
- 4.D.02-2 Launch Restraints, 16 Inch Cassegrain Telescope

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 4. SUPPORT EQUIPMENT (Continued)
- 4.D. Miscellaneous Equipment and Materials (Continued)
- 4.D.03 Undefined Support Equipment
- 4.D.03-1 Workspace Equipment and Materials, 0.9 M. Narrow Field UV
Telescope Experiments
- 4.D.03-2 Workspace Equipment and Materials, Wide Field UV
Telescope Experiments
- 4.D.04 Cameras, Photographic and Film/Accessories
- 4.D.04-1 Film Cartridge
- 4.D.04-2 Trace Recording Camera
- 4.D.04-3 Photographic Camera
- 4.D.04-4 Visible Cine-Photographic Camera
- 4.D.04-5 Camera Timer, Programmable
- 4.D.04-6 Photograph Prints
- 4.D.04-7 Polaroid Camera
- 4.D.04-8 Roll Film Camera, 35 mm
- 4.D.04-9 Movie Camera, 35 mm
- 4.D.04-10 Plate Film Camera
- 4.D.05 Recorders, Tape
- 4.D.05-1 Voice Recorder, Tape
- 4.D.05-2 Tape Cartridges and Reels
- 4.D.06 Cleaning/Decontamination Equipment/Materials
- 4.D.06-1 Disinfectant
- 4.D.07 Cameras, Electronic
- 4.D.07-1 S.E.C. Vidicon
- 4.D.07-2 Combined Electronic/Backup Film Camera
- 4.D.07-3 Television Camera
- 4.D.07-4 Video Camera, Commercial Color
- 4.D.07-5 Video Camera, Standard Black and White
- 4.D.08 Manual Recording Equipment and Supplies
- 4.D.08-1 Writing Instruments (Pens, Pencils, etc.)
- 4.D.08-2 Writing Materials (Paper, Log Books, etc.)
- 4.D.09 Inspection Aids
- 4.D.09-1 Microscopes
- 4.D.10 Data Recorders, Type Unspecified
- 4.D.11 Freeze/Vacuum Drying Equipment

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 4. SUPPORT EQUIPMENT (Continued)
- 4.D Miscellaneous Equipment and Materials (Continued)
- 4.D.12 Vacuum Pumps
- 4.D.13 Power Conditioning and Distribution System
- 4.D.14 Heat Rejection System
- 4.D.15 Materials Analysis Equipment
- 4.D.16 Open Materials
- 4.D.17 Photographic/Film Processing Equipment (See also 4.B.08)
- 4.D.18 Tools, General Purpose
- 4.D.19 Freezing/Refrigeration Equipment
- 4.D.20 Stowage Containers (for Experiment Equipment and Materials)
- 4.D.21 Portable Lamps
- 4.D.22 Laboratory Benches
- 4.D.22-1 General Purpose Laboratory Installation (MS)

- 4.E Life Support and Protective Equipment
- 4.E.01 Toxic Materials Protection Equipment
- 4.E.02 Pressure Suits and Associated Life Support Equipment
- 4.E.02-1 EVA Space Suit
- 4.E.02-2 (Not Assigned)
- 4.E.02-3 Biopack
- 4.E.03 Eye Protection Equipment
- 4.E.03-1 Laser Protection Eyeglasses
- 4.E.04 Fire Detection and Control Equipment
- 4.E.04-1 Accident Control System (Materials Sciences)
- 4.E.05 Integrated Spacecraft Water Supply System
- 4.E.06 Integrated Spacecraft Oxygen Supply System

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 4. SUPPORT EQUIPMENT (Continued)
- 4.E Life Support and Protective Equipment (Continued)
- 4.E.07 Integrated Spacecraft Waste Management System
- 4.E.08 Integrated Spacecraft Advanced Cooling System
- 4.E.09 (Not Assigned)
- 4.E.10 Personnel Clothing, Garments and Accessories
- 4.E.10-1 Constant Wear Garment
- 4.E.11 Tether and Control Unit (for EVA)

- 4.F Subsatellites
- 4.F.01 Comm/Nav Subsatellites
- 4.F.01-1 Satellite Navigation Subsatellite
- 4.F.01-2 Laser Communication Subsatellite
- 4.F.01-3 Surveillance/Search and Rescue Subsatellite
- 4.F.01-4 Laser Ranging Subsatellite
- 4.F.01-5 Plasma Propagation Subsatellite
- 4.F.01-6 Multipath Measurements Subsatellite

- 4.F.02 Physics Subsatellites
- 4.F.03 Teleoperator Task Board Subsatellite

TASK DEPENDENCY REFERENCE LIST
- NUMERICAL LISTING -

5. ENVIRONMENT

5.A Acceleration and Gravity

5.A.01 Zero-G
5.A.01-1 $< 10^{-4}$ G

5.A.02 One-G

5.A.03 Artificial-G (Except Rotational)

5.A.04 Rotational-G

5.B Illumination

5.B.01 Artificial Illumination

5.B.02 Solar Illumination

5.B.03 Stellar Illumination

5.C Pressure

5.C.01 Atmospheric Pressure

5.C.02 Atmospheric Composition

5.D Temperature

5.E Noise

5.F Radiation (Ionizing)

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

5. ENVIRONMENT (Continued)
- 5.G Radiation (Radio Frequency)
- 5.H Extravehicular Environment
(Includes 5.B + 5.C + 5.D; may include 5.F and/or 5.G)
- 5.I Earth Atmosphere
- 5.I.01 Meteorological Conditions
- 5.J Fire and/or Explosion Hazard
- 5.J.01 Combustible Gas Mixtures
- 5.K Intravehicular Environment (5.B + 5.C + 5.D)
- 5.L Object/Vehicle Relationship
- 5.L.01 Relative Velocity
- 5.L.02 Data-Taking Time
- 5.L.03 Distance
- 5.L.04 Relative Position

TASK DEPENDENCY REFERENCE LIST

- NUMERICAL LISTING -

- 6. MISSION CONSIDERATIONS
 - 6.A Mission Events
 - 6.A.01 Mission Time
 - 6.A.01-1 Total Mission Time Schedule
 - 6.A.01-2 Elapsed Time
 - 6.A.01-3 Projected Time
 - 6.A.01-4 Actual Time
 - 6.A.02 Mission Schedule

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

**APPENDIX E
FLIGHT EXPERIMENT TASK-SKILL LIST**



APPENDIX E
FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING
EXPLANATION OF TASK-SKILLS

The approach developed to accomplish skill determination was to convert the brief task statement, or applicable portion thereof, into a task-skill title. A task-skill title is a brief phrase which denotes a specific equipment- or procedure-oriented crew function. The task-skill is derived from the primary task dependency and the primary crew function, within the context of the experiment and the task. Some task statements have but one associated task-skill; others, because of the level of complexity or generality of the task statement, have generated two or more task-skill titles. Each task-skill was given a 4-digit code number to avoid duplication in the task-skill processing. 2,044 task-skills were identified across the forty-eight (48) experiments subjected to detailed analysis in the original study. An additional 293 task-skills were identified in the experiments analyzed in the current study, for a total of 2,337. A complete listing, in numerical order, of the identified task-skill titles is included on the following pages of this appendix. Those task-skills which were identified in the current study, and which have been related to Primary Occupational Skills, are preceded by an asterisk (e.g., *0079 TV Camera Inspector). The correlation between Task-Skills and Occupational Skills may be found in Section 3.0 of this report. The Task/Skill Requirements data sheets for each of the experiments, identifying basic functions, task statements, crew functions, operating environments, dependencies, and the associated task-skills and occupational skills, are compiled into a separate volume of the report, Appendix H. A more thorough explanation of the Task-Skill concept may be found in Section 2.0 of the Technical Report.

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0001-0050

*0001 Telescope Inspector
 0002 Telescope Cover Remover
 0003 Launch Restraint Remover
 *0004 Telescope Optics Cleaner
 0005 SITOS Optics Cleaner
 0006 Spectrometer Installer
 0007 Spectrometer Unstower
 0008 Spectrometer Translocator
 0009 Airlock Status Monitor
 0010 Airlock Inside Hatch Opener
 0011 Magnetometer Remover
 0012 VLF Sensor Remover
 0013 Probe Remover
 0014 Ion Trap Remover
 0015 Probe Gas Distribution Monitor
 0016 Particle Sensor Repairer
 0017 Particle Sensor Remover
 0018 VLF Sensor Repairer
 0019 Gas Temperature Chamber Remover
 0020 Particle Sensor Translocator
 0021 VLF Sensor Translocator
 0022 Magnetometer Translocator
 0023 Probe Translocator
 0024 Ion Trap Translocator
 0025 Gas Temperature Chamber Translocator
 *0026 TV Camera Translocator
 0027 Photometer Translocator
 0028 Spectrometer Cable Selector
 0029 Spectrometer Cable Router
 0030 Spectrometer Cable Connector
 0031 Airlock Inside Hatch Closer
 0032 Airlock Depressurization Actuator
 0033 Airlock Outside Hatch Opener
 0034 Rail/Boom Extension Actuator
 0035 Instrument Power Actuator
 *0036 Spectrometer Control Actuator
 0037 Spectrometer Operating Status Monitor
 *0038 Spectrometer Fault Identifier
 *0039 Camera Installer
 *0040 Spectrometer Tester
 0041 Gas Temperature Chamber Assembler
 0042 Gas Temperature Chamber Installer
 0043 Spectrometer Grating Remover
 0044 Spectrometer Grating Installer
 0045 Film Cartridge Remover
 *0046 Film Cartridge Installer
 0047 Oscilloscope Repairer
 0048 Oscilloscope Fault Identifier
 0049 Ion Trap Installer
 0050 Probe Installer



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0051-0100

0051 Magnetometer Installer
0052 VLF Sensor Installer
0053 Photometer Unstower
*0054 TV Camera Unstower
0055 Gas Temperature Chamber Unstower
0056 Ion Trap Unstower
0057 Probe Unstower
0058 Magnetometer Unstower
0059 VLF Sensor Unstower
0060 Particle Sensor Unstower
0061 Spacecraft Exterior Translationer
0062 Photometer Stower
0063 Spectrometer Stower
*0064 TV Camera Stower
0065 Gas Temperature Chamber Stower
0066 Ion Trap Stower
0067 Probe Stower
0068 Magnetometer Stower
0069 VLF Sensor Stower
0070 Particle Sensor Stower
0071 Calibration Equipment Installer
*0072 Spectrometer Calibrator
0073 Spectrometer Optics Inspector
0074 Camera Lens Inspector
0075 Photometer Optics Inspector
0076 TV Camera Optics Inspector
0077 Photometer Assembly Inspector
0078 Spectrometer Assembly Inspector
*0079 TV Camera Inspector
0080 Gas Temperature Chamber Inspector
0081 Ion Trap Assembly Inspector
0082 Probe Assembly Inspector
0083 Magnetometer Assembly Inspector
0084 VLF Sensor Assembly Inspector
0085 Particle Sensor Assembly Inspector
0086 Photometer Calibrator
0087 Gas Temperature Chamber Calibrator
0088 Ion Trap Calibrator
0089 Probe Calibrator
0090 Magnetometer Calibrator
0091 VLF Sensor Calibrator
0092 Particle Sensor Calibrator
0093 Optical Equipment Cleaner
0094 Photometer Optics Cleaner
*0095 Spectrometer Optics Cleaner
*0096 TV Camera Optics Cleaner
*0097 Camera Lens (Optics) Cleaner
0098 Magnetometer Repairer
0099 Probe Repairer
0100 Gas Temperature Chamber Repairer

0101 Gas Temperature Chamber Fault Identifier
0102 Ion Trap Fault Identifier
0103 Probe Fault Identifier
0104 Magnetometer Fault Identifier
0105 VLF Sensor Fault Identifier
0106 Electronic Instruments Tester
0107 Photometer Module Remover
0108 Photometer Module Installer
*0109 Spectrometer Module Remover
*0110 Spectrometer Module Installer
*0111 TV Camera Module Remover
*0112 TV Camera Module Installer
0113 Gas Temperature Chamber Module Remover
0114 Gas Temperature Chamber Module Installer
0115 Ion Trap Module Remover
0116 Ion Trap Module Installer
0117 Probe Module Remover
0118 Probe Module Installer
0119 Magnetometer Module Remover
0120 Magnetometer Module Installer
0121 VLF Sensor Module Remover
0122 VLF Sensor Module Installer
0123 Particle Sensor Module Remover
0124 Particle Sensor Module Installer
0125 Gas Canister Unstower
0126 Gas Canister Translocator
0127 Gas Canister Cable Selector
0128 Gas Canister Cable Router
0129 Gas Canister Cable Connector
0130 Gas Canister Installer
0131 Rail/Boom Retraction Actuator
0132 Airlock Outside Hatch Closer
0133 Airlock Pressurization Actuator
0134 Spectrometer Cable Disconnecter
0135 Gas Canister Cable Disconnecter
0136 Gas Canister Remover
0137 Gas Canister Stower
0138 Rail/Boom Position Monitor
0139 Instrument Power Monitor
0140 Particle Sensor Installer
0141 Particle Sensor Deployer
0142 Spacecraft Airlock Translationer
0143 Particle Sensor Cable Selector
0144 Particle Sensor Cable Router
0145 Particle Sensor Cable Connector
0146 Particle Sensor Aligner
0147 Particle Sensor Optics Calibrator
0148 Oscilloscope Unstower
0149 Oscilloscope Installer
0150 Particle Sensor Retractor



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0151-0200

0151 Film Cartridge Stower
0152 Cable Stower
0153 Oscilloscope Stower
0154 Camera Stower
0155 Particle Sensor Optics Inspector
0156 Particle Sensor Optics Cleaner
0157 Particle Sensor Fault Identifier
*0158 Camera Module Remover
0159 Oscilloscope Module Remover
*0160 Camera Module Installer
0161 Oscilloscope Module Installer
0162 Telescope Baffle Deployment Actuator
0163 Telescope Baffle Status Monitor
0164 SITOS Unstower
0165 SITOS Translocator
0166 SITOS Installer
0167 SITOS Tester
0168 SITOS Calibrator
0169 SITOS Grating Remover
0170 SITOS Grating Installer
0171 Telescope Baffle Retraction Actuator
0172 Launch Restraint Installer
0173 SITOS Remover
0174 SITOS Stower
0175 Telescope Coverer
0176 Spectrometer Grating Inspector
0177 SITOS Grating Inspector
0178 Telescope Optics Inspector
0179 SITOS Optics Inspector
0180 SITOS Assembly Inspector
0181 Camera Assembly Inspector
0182 SITOS Module Inspector
0183 SITOS Module Remover
0184 SITOS Module Installer
0185 Ion Trap Repairer
0186 Combustible Gas Distribution Monitor
*0187 Telescope Module Remover
*0188 Telescope Module Installer
0189 Spectrometer Adjuster
0190 Oscilloscope Adjuster
0191 Amplifier Adjuster
0192 Phase Shifter Adjuster
0193 Phase Sensitive Detector Adjuster
0194 Null Signal System Adjuster
0195 A/D Converter Adjuster
0196 Molecular Beam Scattering Device Assembler
0197 Molecular Beam Scattering Device Disassembler
0198 Molecular Beam Scattering Device Installer
0199 Mounting Platform Installer
0200 Instrument Pointing Direction Monitor



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #0201-0250

0201 Instrument Pointing Direction Controller
0202 Tape Recorder Actuator
0203 Tape Cartridge Stower
*0204 Camera Mode Monitor
0205 Molecular Beam Scattering Data Analyst
*0206 Radio Communicator
0207 Molecular Beam Scattering Data Communicator
0208 Molecular Beam Scattering Research Planner
*0209 Scanner Mode Monitor
0210 Molecular Beam Scattering Device Inspector
0211 Molecular Beam Scattering Device Fault Identifier
*0212 TV Camera Mode Monitor
0213 Amplifier Fault Identifier
0214 Phase Shifter Fault Identifier
0215 Phase Sensitive Detector Fault Identifier
0216 Null Signal System Fault Identifier
0217 A/D Converter Fault Identifier
0218 Molecular Beam Scattering Device Module Remover
0219 Molecular Beam Scattering Device Module Installer
0220 Amplifier Module Remover
0221 Amplifier Module Installer
0222 Phase Shifter Module Remover
0223 Phase Shifter Module Installer
0224 Phase Sensitive Detector Module Remover
0225 Phase Sensitive Detector Module Installer
0226 A/D Converter Module Remover
0227 A/D Converter Module Installer
0228 Null Signal System Module Remover
0229 Null Signal System Module Installer
0230 Gas-Surface Interaction Device Unstower
0231 Gas-Surface Interaction Device Assembler
0232 Gas-Surface Interaction Device Installer
0233 Test Surface Remover
0234 Test Surface Installer
0235 Gas-Surface Interaction Device Plating Monitor
0236 Gas-Surface Interaction Device Plating Control Actuator
0237 Gas-Surface Interaction Device Disassembler
0238 Test Surface Block Remover
0239 Test Surface Block Installer
0240 Plating Material Boat Remover
0241 Plating Material Boat Installer
0242 Gas-Surface Interaction Operations Monitor
0243 Gas-Surface Interaction Control Actuator
0244 Gas-Surface Interaction Control Deactuator
*0245 Camera Control Actuator
0246 Gas-Surface Interaction Data Recorder
0247 Gas-Surface Interaction Observer
0248 Gas-Surface Interaction Data Interpreter
0249 Gas-Surface Interaction Records Organizer
0250 Hard Copy Records Stower



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0251-0300

0251 Data Recording Stower
0252 Astronomy C/D Console Self-Test Control Actuator
0253 Astronomy C/D Console Self-Test Display Monitor
0254 Telescope Drive Inspector
0255 Telescope Drive Tester
0256 Telescope Drive Control Actuator
0257 Telescope Drive Control Deactuator
0258 Camera Focusing Tester
0259 Spectrograph Focusing Tester
0260 Telescope Chamber Inspector
0261 Telescope Chamber Hatch Closer
0262 Telescope Chamber Status Monitor
0263 Telescope Chamber Depressurization Actuator
0264 Telescope Status Monitor
*0265 Telescope Mode Selector
0266 Telescope Mode Control Actuator
*0267 Spectrometer Mode Selector
*0268 TV Mode Selector
0269 Grating Mode Selector
0270 Band Filter Mode Selector
*0271 Camera Mode Selector
0272 Star Tracker Mode Selector
0273 Stellar Ultraviolet Observation Mode Selector
0274 Computer Mode Selector
0275 Amplifier Mode Selector
0276 Phase Shifter Mode Selector
0277 Spectrometer Mode Control Actuator
0278 TV Mode Control Actuator
0279 Grating Mode Control Actuator
0280 Band Filter Mode Control Actuator
0281 Camera Mode Control Actuator
0282 Star Tracker Mode Control Actuator
0283 Stellar Ultraviolet Observation Mode Control Actuator
0284 Computer Mode Control Actuator
0285 Amplifier Mode Control Actuator
0286 Phase Shifter Mode Control Actuator
0287 Film Cartridge Inspector
0288 Film Cartridge Unstower
0289 Film Changing System Actuator
0290 Film Changing System Monitor
0291 Star Tracker Unstower
*0292 Camera Unstower
0293 Star Tracker Inspector
*0294 Camera Inspector
0295 Grating Inspector
0296 Band Filter Inspector
*0297 Telescope Aligner
0298 Star Tracker Aligner
0299 Camera Aligner
0300 Spectrometer Aligner

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0301-0350

0301	Grating Aligner
0302	Band Filter Aligner
*0303	Telescope Unstower
0304	Star Tracker Cap Remover
0305	Star Tracker Installer
*0306	TV Camera Installer
0307	Camera Cap Remover
0308	Telescope Cap Remover
0309	TV Camera Cap Remover
0310	Grating Remover
0311	Grating Installer
0312	Band Filter Remover
0313	Band Filter Installer
*0314	Camera Remover
0315	Spectrometer Remover
0316	Telescope Chamber Outside Hatch Control Actuator
0317	Telescope Deployment Status Monitor
0318	Telescope Deployment Control Actuator
0319	Computer Control Deactuator
*0320	Telescope Control Deactuator
0321	Star Tracker Stower
0322	Telescope Position Monitor
0323	Telescope Retraction Actuator
0324	Telescope Pointing Status Monitor
0325	Telescope Pointing Control Actuator
0326	Stellar Ultraviolet Observer
0327	Stellar Ultraviolet Evaluator
*0328	Film Processor
0329	Film Evaluator
0330	Stellar Ultraviolet Emission Classifier
0331	Stellar Ultraviolet Research Planner
0332	Stellar Ultraviolet Data Analyst
0333	Star Tracker Controller
*0334	TV Camera Controller
*0335	Camera Controller
*0336	Spectrometer Controller
*0337	Telescope Controller
0338	Telescope System Controller
0339	Camera Focusing Monitor
0340	Spectrograph Focusing Monitor
0341	Camera Focusing Aligner
0342	Spectrograph Focusing Aligner
0343	Star Tracker Module Remover
0344	Star Tracker Module Installer
*0345	TV System Module Remover
*0346	TV System Module Installer
0347	Band Filter Module Remover
0348	Band Filter Module Installer
0349	Combustible Gas Mixing Controller
0350	Combustible Gas Mixture Stower

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0351-0400

0351 Zero-G Combustion Research Planner
 0352 Spectrograph Calibrator
 0353 Gas Chromatograph Calibrator
 0354 Combustible Gas Tube Filler
 0355 Fire Detection Equipment Monitor
 0356 Fire Control Equipment Controller
 0357 Zero-G Combustion Control Actuator
 0358 Zero-G Combustion Display Monitor
 0359 Combustible Gas Distribution Control Actuator
 0360 Temperature Measurement Observer
 0361 Temperature Measurement Recorder
 0362 Pressure Measurement Observer
 0363 Pressure Measurement Recorder
 0364 Flame Composition Measurement Observer
 0365 Flame Composition Measurement Recorder
 0366 Flame Visible Structure Observer
 0367 Probe Gas Distribution Control Actuator
 0368 Zero-G Combustion Data Analyst
 0369 Zero-G Combustion Observer
 0370 Zero-G Combustion Device Fault Identifier
 0371 Zero-G Combustion Device Adjustor
 0372 Spectrograph Fault Identifier
 0373 Spectrograph Adjustor
 0374 Gas Chromatograph Fault Identifier
 0375 Gas Chromatograph Adjustor
 *0376 Calorimeter Fault Identifier
 0377 Calorimeter Adjustor
 0378 Zero-G Combustion C/D Equipment Fault Identifier
 0379 Zero-G Combustion C/D Equipment Adjustor
 *0380 Calorimeter Calibrator
 0381 Laser Fuel and Oxidizer Installer
 0382 Contamination Coupon Translocator
 0383 Contamination Coupon Installer
 0384 Chemical Laser Installer
 0385 Contamination Coupon Remover
 0386 Chemical Laser Operation Monitor
 0387 Contamination Coupon Sample Measurer
 0388 Chemical Laser Control Actuator
 0389 Chemical Laser Control Deactuator
 0390 Zero-G Laser Operation Observer
 *0391 Calorimeter Operation Monitor
 *0392 Calorimeter Control Actuator
 *0393 Calorimeter Control Deactuator
 0394 Chemical Laser Temperature Monitor
 0395 Gas Canister Deployment Control Actuator
 0396 Gas Canister Deployment Monitor
 0397 Physics Subsatellite Flight Controller
 0398 Physics Subsatellite Flight Monitor
 0399 Space Gas Reactions Research Planner
 0400 Space Gas Reactions Observer

0401 Chemical Canister Deployment Control Actuator
 0402 Chemical Canister Deployment Monitor
 0403 Chemical Canister Unstower
 0404 Chemical Canister Translocator
 0405 Photometer Installer
 0406 Physics Subsatellite Instrumentation Monitor
 0407 Physics Subsatellite Instrumentation Controller
 0408 Instrument Power Deactuator
 *0409 Spectrometer Control Deactuator
 0410 Probe Operating Status Monitor
 0411 Probe Control Actuator
 0412 Probe Control Deactuator
 0413 Photometer Operating Status Monitor
 0414 Photometer Control Actuator
 0415 Photometer Control Deactuator
 0416 Rail/Boom-Cloud Observer
 0417 Rail/Boom-Cloud Position Determiner
 0418 Physics Subsatellite-Cloud Observer
 0419 Physics Subsatellite-Cloud Position Determiner
 0420 Space Gas Reactions Data Monitor
 0421 Space Gas Reactions Observation Director
 0422 Chemical Canister Chemical Release Actuator
 0423 Space Gas Reactions Data Recorder
 0424 Refueling System Control Actuator
 0425 Refueling System Control Deactuator
 0426 Refueling System Monitor
 0427 Teleoperator Refueling Control Actuator
 0428 Teleoperator Refueling Control Deactuator
 0429 Teleoperator Fuel Status Monitor
 0430 Battery Charging System Control Actuator
 0431 Battery Charging System Control Deactuator
 0432 Battery Charging System Monitor
 0433 Teleoperator Battery Charging Control Actuator
 0434 Teleoperator Battery Charging Control Deactuator
 0435 Teleoperator Battery Charge Status Monitor
 0436 Teleoperator Subsystem Inspector
 0437 Teleoperator Subsystem Tester
 0438 Teleoperator Deployment Mechanism Monitor
 0439 Teleoperator Deployment Control Actuator
 0440 Docking Adapter Status Monitor
 0441 Docking Adapter Release Control Actuator
 0442 Teleoperator Systems Monitor
 0443 Teleoperator Retrieval Mechanism Monitor
 0444 Teleoperator Retrieval Control Actuator
 0445 Teleoperator Flight Observer
 0446 Teleoperator Flight Controller
 0447 Teleoperator Performance Evaluator
 0448 Teleoperator Deficiency Determiner
 0449 Teleoperator Design Evaluator
 0450 Teleoperator Design Planner

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #0451-0500

0451 Teleoperator/Man Interface Deficiency Determiner
 0452 Teleoperator/Man Interface Design Evaluator
 0453 Teleoperator/Man Interface Design Planner
 0454 Spacecraft External Surface Inspector
 0455 Teleoperator Docking Observer
 0456 Teleoperator Communication System Controller
 0457 Teleoperator Communication System Evaluator
 0458 Teleoperator Communication Deadzone Determiner
 0459 Teleoperator Multipath Effects Determiner
 0460 Teleoperator Subsystem Adjuster
 0461 Teleoperator System Inspector
 0462 Teleoperator System Fault Identifier
 0463 Teleoperator Manipulations Observer
 0464 Teleoperator Manipulations Controller
 0465 Lighting Adaptation Evaluator
 0466 Teleoperator Video Systems Evaluator
 0467 Teleoperator Video Control Actuator
 0468 Teleoperator Video Presentation Observer
 0469 Teleoperator Video Acquisition Controller
 0470 Task Board Docking Point Identifier
 0471 Teleoperator Video Control Deactuator
 0472 Task Board Observer
 0473 Task Board Subsatellite Observer
 0474 Task Board Subsatellite Release Control Actuator
 0475 Spacecraft Relative Velocities Determiner
 0476 Task Board Subsatellite Inspector
 0477 Teleoperator Camera Controller
 0478 Teleoperator Stability Status Monitor
 0479 Teleoperator Attitude Status Monitor
 0480 Teleoperator Undocking Observer
 0481 Teleoperator Docking Release Actuator
 0482 Teleoperator Manipulations Evaluator
 0483 Laser Optics Aligner
 0484 Laser Optics Installer
 0485 Laser Optics Remover
 0486 Laser Electronics Installer
 0487 Laser Electronics Adjuster
 0488 Laser Electronics Remover
 0489 Comm/Nav Subsatellite Launch Controller
 0490 Laser Control Deactuator
 0491 Protective Eyeglasses Donner
 0492 Laser Operating Status Monitor
 0493 Laser Communication Data Evaluator
 0494 Laser Tracking Signal Monitor
 0495 Laser Tracking System Controller
 0496 Radio Transmitter Assembler
 0497 Radio Transmitter Disassembler
 0498 Radio Transmitter Module Remover
 0499 Radio Transmitter Module Installer
 0500 Radio Receiver Assembler

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0501-0550

0501	Radio Receiver Disassembler
0502	Radio Receiver Module Remover
0503	Radio Receiver Module Installer
0504	Radio Antenna Assembler
0505	Radio Antenna Disassembler
0506	Radio Antenna Module Remover
0507	Radio Antenna Module Installer
0508	Radio Antenna Deployment Control Actuator
0509	Radio Antenna Translocator
0510	Radio Antenna Installer
0511	Radio Receiver Calibrator
0512	Radio Frequency Control Actuator
0513	MW Communications Research Planner
0514	Radio Transceiver Control Deactuator
0515	Meteorological Condition Determiner
*0516	Meteorological Condition Observer
0517	Radio Antenna Pointing Controller
0518	MW Communications Data Evaluator
*0519	Computer Module Remover
*0520	Computer Module Installer
0521	Radio Transmitter Fault Identifier
0522	Radio Receiver Fault Identifier
*0523	Computer Fault Identifier
0524	Radio Antenna Fault Identifier
0525	Radio Transponder Assembler
0526	Interferometer Antenna Array Assembler
0527	Radio Transponder Installer
0528	Radio Transponder Calibrator
0529	Radio Transponder Disassembler
0530	Interferometer Antenna Array Installer
0531	Interferometer Antenna Array Disassembler
0532	Radio Transponder Control Deactuator
0533	Radio Transponder Operating Status Monitor
0534	Surveillance/S&R Data Processing Monitor
0535	Surveillance/S&R Data Evaluator
0536	Radio Transponder Repairer
0537	Comm/Nav C/D Equipment Repairer
0538	Comm/Nav Subsatellite Repairer
0539	Comm/Nav Subsatellite C/D Equipment Repairer
*0540	Computer Repairer
0541	Interferometer Antenna Array Repairer
0542	Radio Transmitter Repairer
0543	Radio Receiver Repairer
0544	Radio Antenna Repairer
0545	Satellite Navigation Equipment Module Remover
0546	Satellite Navigation Equipment Module Installer
0547	Radio Transmitter Remover
0548	Radio Transmitter Installer
0549	Radio Antenna Remover
0550	Radio Receiver Remover

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0551-0600

0551 Radio Receiver Installer
0552 Code Generator Remover
0553 Code Generator Installer
0554 Frequency Synthesizer Remover
0555 Frequency Synthesizer Installer
0556 Precision Clock Remover
0557 Precision Clock Installer
0558 Comm/Nav Subsatellite Module Remover
0559 Comm/Nav Subsatellite Module Installer
0560 Comm/Nav Subsatellite Module Aligner
0561 Radio Antenna-Transmitter Calibrator
0562 Radio Transmitter Power Control Actuator
0563 Radio Receiver Power Control Actuator
0564 Radio Transmitter Stower
0565 Radio Receiver Stower
0566 Radio Antenna Stower
0567 Frequency Synthesizer Stower
0568 Code Generator Stower
0569 Precision Clock Stower
0570 Comm/Nav Subsatellite Stower
0571 Radio Transmitter Power Control Deactuator
0572 Radio Receiver Power Control Deactuator
0573 Comm/Nav Subsatellite Flight Controller
0574 Radio Transmitter Operation Monitor
0575 Comm/Nav C/D Equipment Fault Identifier
0576 Frequency Synthesizer Fault Identifier
0577 Frequency Synthesizer Repairer
0578 Code Generator Fault Identifier
0579 Code Generator Repairer
0580 Precision Clock Fault Identifier
0581 Precision Clock Repairer
0582 Comm/Nav Subsatellite Fault Identifier
0583 Laser Transmitter Assembler
0584 Laser Transmitter Disassembler
0585 Laser Transmitter Module Remover
0586 Laser Transmitter Module Installer
0587 Laser Transmitter Remover
0588 Laser Transmitter Installer
0589 Laser Receiver Assembler
0590 Laser Receiver Disassembler
0591 Laser Receiver Module Remover
0592 Laser Receiver Module Installer
0593 Laser Receiver Remover
0594 Laser Receiver Installer
0595 Comm/Nav C/D Equipment Module Remover
0596 Comm/Nav C/D Equipment Module Installer
0597 Laser Transmitter Control Deactuator
0598 Laser Receiver Control Deactuator
0599 Laser Transmitter Controller
0600 Laser Radar Target Observer

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0601-0650

0601 Laser Radar Data Evaluator
 0602 Laser Radar Display Observer
 0603 Map Observer
 0604 Topographic Map-Match Determiner
 0605 Laser Transmitter Calibrator
 0606 Laser Transmitter Optics Cleaner
 0607 Laser Transmitter Fault Identifier
 0608 Laser Receiver Fault Identifier
 0609 Computer Program Determiner
 0610 Computer Program Controller
 *0611 Radar Transmitter Unstower
 0612 Radar Transmitter Assembler
 *0613 Radar Transmitter Tester
 0614 Radar Transmitter Installer
 *0615 Radar Transmitter Module Remover
 *0616 Radar Transmitter Module Installer
 0617 Radar Transmitter Remover
 0618 Radar Transmitter Disassembler
 0619 Radar Transmitter Stower
 0620 Radar Receiver Assembler
 0621 Radar Receiver Disassembler
 0622 Radar Receiver Installer
 *0623 Radar Receiver Module Installer
 *0624 Radar Receiver Module Remover
 0625 Radar Receiver Remover
 0626 Radar Transmitter Stower
 *0627 Radar Receiver Tester
 *0628 Radar Transmitter Unstower
 0629 Laser Transmitter Unstower
 0630 Laser Transmitter Tester
 0631 Laser Receiver Unstower
 0632 Laser Receiver Tester
 *0633 TV Camera Tester
 0634 Radiometer Assembler
 0635 Radiometer Disassembler
 0636 Radiometer Installer
 *0637 Radiometer Module Installer
 *0638 Radiometer Module Remover
 0639 Radiometer Remover
 0640 Radiometer Stower
 *0641 Radiometer Tester
 *0642 Radiometer Unstower
 0643 Star Tracker Assembler
 *0644 Radiometer Mode Monitor
 0645 Star Tracker Remover
 0646 Star Tracker Tester
 0647 Inertial Navigation Sensor Installer
 0648 Inertial Navigation Sensor Remover
 0649 Inertial Navigation Sensor Stower
 0650 Inertial Navigation Sensor Tester

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0651-0700

0651 Inertial Navigation Sensor Unstower
0652 Magnetostatic Device Assembler
*0653 Polarimeter Mode Monitor
0654 Magnetostatic Device Installer
0655 Magnetostatic Device Module Installer
0656 Magnetostatic Device Module Remover
0657 Magnetostatic Device Remover
0658 Magnetostatic Device Stower
0659 Magnetostatic Device Tester
0660 Magnetostatic Device Unstower
*0661 TV Camera Remover
*0662 Telemetry Equipment Control Actuator
0663 Telemetry Equipment Control Deactuator
*0664 Radar Transmitter Control Deactuator
0665 Radar Transmitter Translocator
*0666 Radar Receiver Control Deactuator
0667 Radar Receiver Translocator
0668 Laser Transmitter Translocator
0669 Laser Receiver Translocator
0670 Laser Receiver Stower
0671 Laser Transmitter Stower
*0672 TV Camera Control Deactuator
*0673 Radiometer Control Deactuator
0674 Radiometer Translocator
0675 Star Tracker Control Deactuator
0676 Star Tracker Translocator
0677 Inertial Navigation Sensor Control Deactuator
0678 Inertial Navigation Sensor Translocator
0679 Magnetostatic Device Control Deactuator
0680 Magnetostatic Device Translocator
0681 Comm/Nav C/D Equipment Control Deactuator
0682 Navigation Signal Comparison Evaluator
*0683 Radar Transmitter Fault Identifier
*0684 Radar Transmitter Repairer
*0685 Radar Receiver Fault Identifier
*0686 Radar Receiver Repairer
0687 Laser Transmitter Repairer
0688 Laser Receiver Repairer
*0689 TV Camera Fault Identifier
*0690 TV Camera Repairer
*0691 Radiometer Fault Identifier
*0692 Radiometer Repairer
0693 Star Tracker Fault Identifier
0694 Star Tracker Repairer
0695 Inertial Navigation Sensor Fault Identifier
0696 Inertial Navigation Sensor Repairer
0697 Magnetostatic Device Fault Identifier
0698 Magnetostatic Device Repairer
0699 Telemetry Equipment Fault Identifier
0700 Telemetry Equipment Repairer

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0701-0750

0701 Microscope Fault Identifier
0702 Microscope Unstower
0703 Microscope Stower
0704 Microscope Translocator
0705 Microscope Repairer
0706 Power Monitoring Device Control Deactuator
0707 Power Monitoring Device Installer
0708 Power Monitoring Device Remover
0709 Power Monitoring Device Fault Identifier
0710 Power Monitoring Device Unstower
0711 Power Monitoring Device Stower
0712 Power Monitoring Device Translocator
0713 Power Monitoring Device Repairer
0714 Waveform Modulator Control Deactuator
0715 Waveform Modulator Module Installer
0716 Waveform Modulator Module Remover
0717 Waveform Modulator Installer
0718 Waveform Modulator Remover
0719 Waveform Modulator Fault Identifier
0720 Waveform Modulator Unstower
0721 Waveform Modulator Stower
0722 Waveform Modulator Translocator
0723 Waveform Modulator Repairer
0724 Spacecraft Plasma Probe Control Deactuator
0725 Spacecraft Plasma Probe Installer
0726 Spacecraft Plasma Probe Remover
0727 Spacecraft Plasma Probe Fault Identifier
0728 Spacecraft Plasma Probe Unstower
0729 Spacecraft Plasma Probe Stower
0730 Spacecraft Plasma Probe Translocator
0731 Spacecraft Plasma Probe Repairer
0732 Temperature Monitoring Device Control Deactuator
0733 Temperature Monitoring Device Installer
0734 Temperature Monitoring Device Fault Identifier
0735 Temperature Monitoring Device Remover
0736 Temperature Monitoring Device Unstower
0737 Temperature Monitoring Device Stower
0738 Temperature Monitoring Device Translocator
0739 Temperature Monitoring Device Repairer
0740 Pressure Monitoring Device Control Deactuator
0741 Pressure Monitoring Device Installer
0742 Pressure Monitoring Device Remover
0743 Pressure Monitoring Device Fault Identifier
0744 Pressure Monitoring Device Unstower
0745 Pressure Monitoring Device Stower
0746 Pressure Monitoring Device Translocator
0747 Pressure Monitoring Device Repairer
0748 Optical Monitoring Device Control Deactuator
0749 Optical Monitoring Device Installer
0750 Optical Monitoring Device Remover

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0751-0800

0751 Optical Monitoring Device Fault Identifier
0752 Optical Monitoring Device Unstower
0753 Optical Monitoring Device Stower
0754 Optical Monitoring Device Translocator
0755 Optical Monitoring Device Repairer
0756 Microwave Transmitter Control Deactuator
0757 Microwave Transmitter Condition Determiner
0758 Microwave Transmitter Inspector
0759 Microwave Transmitter Module Installer
0760 Microwave Transmitter Module Remover
0761 Microwave Transmitter Installer
0762 Microwave Transmitter Remover
0763 Microwave Transmitter Fault Identifier
0764 Microwave Transmitter Unstower
0765 Microwave Transmitter Stower
0766 Microwave Transmitter Translocator
0767 Microwave Transmitter Repairer
0768 Microwave Test Structure Condition Determiner
0769 Microwave Test Structure Inspector
0770 Microwave Test Structure Module Installer
0771 Microwave Test Structure Module Remover
0772 Microwave Test Structure Installer
0773 Microwave Test Structure Remover
0774 Microwave Test Structure Unstower
0775 Microwave Test Structure Stower
0776 Microwave Test Structure Disassembler
0777 Microwave Test Structure Assembler
0778 Microwave Test Structure Translocator
*0779 Spectrometer Repairer
0780 Radio Receiver Cable Connector
0781 RV Launch Cable Connector
0782 Radio Transmitter Cable Connector
0783 VSWR Measuring Equipment Cable Connector
0784 Attitude Measuring Equipment Cable Connector
0785 Data Recorder Cable Connector
0786 Telemetry Cable Connector
*0787 Spectrometer Mode Monitor
0788 Comm/Nav Subsattellite Launch Cable Connector
0789 RV Fault Identifier
0790 RV Repairer
0791 VSWR Measuring Equipment Fault Identifier
0792 Attitude Measuring Equipment Fault Identifier
0793 Data Recorder Fault Identifier
0794 Cable Fault Identifier
*0795 Electronic Equipment Fault Identifier
0796 VSWR Measuring Equipment Repairer
0797 Attitude Measuring Equipment Repairer
0798 Data Recorder Repairer
0799 Cable Repairer
0800 Radar Receiver Cable Connector

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #0801-0850

0801	Radar Antenna Remover
0802	Radar Antenna Installer
0803	Radar Transmitter Cable Connector
0804	Radar Antenna Cable Connector
0805	Radar Antenna Fault Identifier
0806	Radar Antenna Repairer
0807	Radar Antenna-Transmitter Calibrator
0808	Radar Transmitter Power Control Actuator
0809	Radar Receiver Power Control Actuator
0810	Radar Transmitter Power Control Deactuator
0811	Radar Receiver Power Control Deactuator
*0812	Radar Transmitter Operation Monitor
0813	Comm/Nav System Tester
0814	Comm/Nav System Test Monitor
0815	Radio Antenna Unstower
0816	Radar Antenna Unstower
0817	Radar Antenna Translocator
0818	Radar Antenna Assembler
0819	Radar Antenna Disassembler
0820	Telemetry Equipment Module Remover
0821	Telemetry Equipment Module Installer
0822	Cloud Chamber Unstower
*0823	Scanner Unstower
0824	Polarimeter Unstower
*0825	Sferics Detector Unstower
0826	Scatterometer Unstower
0827	Microscope Inspector
*0828	Scanner Inspector
*0829	Radiometer Inspector
0830	Scatterometer Inspector
*0831	Polarimeter Inspector
*0832	Sferics Detector Inspector
*0833	Spectrometer Inspector
0834	Cloud Chamber Inspector
0835	Microscope Calibrator
0836	Scanner Calibrator
*0837	Radiometer Calibrator
0838	Scatterometer Calibrator
0839	Polarimeter Calibrator
0840	Sferics Detector Calibrator
0841	Cloud Chamber Calibrator
*0842	Scanner Control Actuator
*0843	Radiometer Control Actuator
*0844	Polarimeter Control Actuator
*0845	Sferics Detector Control Actuator
*0846	Telescope Control Actuator
*0847	Computer Control Actuator
*0848	Camera Control Deactuator
*0849	Scanner Control Deactuator
0850	Scatterometer Control Actuator

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0851-0900

0851 Scatterometer Control Deactuator
 *0852 Film Stower
 *0853 Sferics Detector Control Deactuator
 0854 Cloud Chamber Control Deactuator
 0855 Cloud Chamber Control Actuator
 0856 Scanner Stower
 0857 Scatterometer Stower
 0858 Sferics Detector Stower
 0859 Telescope Stower
 0860 Cloud Chamber Stower
 0861 Cloud Physics Process Observer
 *0862 Tape Recorder Controller
 0863 Cloud Physics Observation Communicator
 0864 Topographic Feature Observer
 0865 Atmospheric Feature Observer
 0866 Topographic Feature Determiner
 0867 Atmospheric Feature Determiner
 0868 Observation Condition Observer
 *0869 Scanner Data Quality Monitor
 *0870 Radiometer Data Quality Monitor
 0871 Scatterometer Data Quality Monitor
 *0872 Spectrometer Data Quality Monitor
 *0873 Polarimeter Data Quality Monitor
 *0874 Telescope Operation Evaluator
 *0875 Camera Operation Evaluator
 *0876 Scanner Operation Evaluator
 *0877 Radiometer Operation Evaluator
 0878 Scatterometer Operation Evaluator
 *0879 Spectrometer Operation Evaluator
 *0880 Polarimeter Operation Evaluator
 0881 Sferics Detector Operation Evaluator
 *0882 Sferics Detector Data Quality Monitor
 0883 Microscope Optics Cleaner
 *0884 Scanner Optics Cleaner
 *0885 Telescope Fault Identifier
 *0886 Camera Fault Identifier
 *0887 Scanner Fault Identifier
 *0888 Scatterometer Fault Identifier
 *0889 Polarimeter Fault Identifier
 *0890 Sferics Detector Fault Identifier
 *0891 Optical Equipment Fault Identifier
 0892 TV Camera Calibrator
 0893 Camera Disassembler
 0894 Camera Assembler
 *0895 Telescope Presentation Observer
 *0896 TV Presentation Observer
 *0897 Scanner Presentation Observer
 *0898 Radiometer Presentation Observer
 *0899 TV Camera Control Actuator
 0900 TV Camera Disassembler

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0901-0950

0901 TV Camera Assembler
0902 Scanner Disassembler
0903 Scanner Assembler
*0904 Scanner Module Remover
*0905 Scanner Module Installer
0906 Polarimeter Disassembler
0907 Polarimeter Assembler
*0908 Polarimeter Module Remover
*0909 Polarimeter Module Installer
0910 Spectrometer Disassembler
0911 Spectrometer Assembler
0912 Telescope Disassembler
0913 Telescope Assembler
*0914 Polarimeter Presentation Observer
*0915 Spectrometer Presentation Observer
*0916 Scanner Mode Selector
*0917 Radiometer Mode Selector
*0918 Polarimeter Mode Selector
*0919 Polarimeter Control Deactuator
0920 Data Photographic Quality Evaluator
*0921 Telescope Pointing Controller
*0922 TV Data Quality Monitor
*0923 TV Camera Operation Evaluator
*0924 Radiometer Optics Cleaner
*0925 Polarimeter Optics Cleaner
*0926 Earth Survey C/D Equipment Module Remover
*0927 Earth Survey C/D Equipment Module Installer
*0928 Earth Survey C/D Equipment Fault Identifier
0929 TV Camera Aligner
0930 Radar Transmitter Aligner
0931 Radar Receiver Aligner
*0932 Radar Transmitter Inspector
*0933 Radar Receiver Inspector
*0934 Radar Presentation Observer
*0935 Radar Transmitter Control Actuator
*0936 Radar Receiver Control Actuator
*0937 Sferics Detector Presentation Observer
*0938 Radar Transmitter Mode Selector
*0939 Radar Receiver Mode Selector
*0940 Sferics Detector Mode Selector
*0941 Forest Fire Disaster Identifier
*0942 Telescope Mode Monitor
*0943 Telescope Mode Recorder
*0944 Radar Data Quality Monitor
*0945 Sferics Detector Optics Cleaner
*0946 Sferics Detector Module Remover
*0947 Sferics Detector Module Installer
0948 Scatterometer Presentation Observer
0949 Scatterometer Mode Selector
0950 TV Camera Cap Installer

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#0951-1000

0951	Camera Cap Installer
0952	Scanner Cap Installer
0953	Film Data Usefulness Determiner
0954	TV Data Usefulness Determiner
0955	Scanner Data Usefulness Determiner
0956	Scatterometer Usefulness Determiner
0957	Scanner Data Evaluator
0958	TV Data Evaluator
0959	Scatterometer Data Evaluator
0960	Scatterometer Optics Cleaner
0961	Scatterometer Module Remover
0962	Scatterometer Module Installer
0963	Telescope Cap Installer
0964	Spectrometer Cap Installer
0965	Radiometer Cap Installer
0966	Scatterometer Cap Installer
0967	Polarimeter Cap Installer
*0968	Composite Materials Research Planner
*0969	Composite Materials Data Recorder
0970	Composite Materials Structure Determiner
*0971	Composite Materials Structure Analyzer
0972	Composite Materials Processing Observer
*0973	Composite Materials Research Evaluator
*0974	Composite Materials Sample Installer
*0975	Composite Materials Sample Unstower
*0976	Composite Materials Sample Translocator
*0977	Composite Materials Sample Remover
*0978	Composite Materials Sample Stower
0979	Furnace Deployer
*0980	Furnace Unstower
*0981	Furnace Module Remover
*0982	Furnace Module Installer
*0983	Furnace Stower
*0984	Furnace Cleaner
*0985	Furnace Operation Monitor
0986	Furnace Disassembler
0987	Furnace Assembler
*0988	Furnace Repairer
*0989	Furnace Fault Identifier
0990	Mixing Unit Deployer
*0991	Mixing Unit Installer
*0992	Mixing Unit Unstower
*0993	Mixing Unit Translocator
*0994	Mixing Unit Remover
0995	Mixing Unit Module Remover
0996	Mixing Unit Module Installer
*0997	Mixing Unit Stower
*0998	Mixing Unit Cleaner
*0999	Mixing Unit Operation Monitor
1000	Mixing Unit Disassembler

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #1001-1050

1001	Mixing Unit Assembler
*1002	Mixing Unit Repairer
*1003	Mixing Unit Fault Identifier
1004	Mold Injection System Deployer
1005	Mold Injection System Unstower
1006	Mold Injection System Module Remover
1007	Mold Injection System Module Installer
1008	Mold Injection System Stower
1009	Mold Injection System Cleaner
1010	Mold Injection System Operation Monitor
1011	Mold Injection System Disassembler
1012	Mold Injection System Assembler
1013	Mold Injection System Repairer
1014	Mold Injection System Fault Identifier
1015	Materials Forming Equipment Deployer
*1016	Materials Forming Equipment Installer
*1017	Materials Forming Equipment Unstower
*1018	Materials Forming Equipment Translocator
1019	Materials Forming Equipment Remover
1020	Materials Forming Equipment Stower
*1021	Materials Forming Equipment Cleaner
1022	Liquid Metal Supply System Deployer
1023	Liquid Metal Supply System Unstower
1024	Liquid Metal Supply System Module Remover
1025	Liquid Metal Supply System Module Installer
1026	Liquid Metal Supply System Stower
1027	Liquid Metal Supply System Cleaner
1028	Liquid Metal Supply System Operation Monitor
1029	Liquid Metal Supply System Disassembler
1030	Liquid Metal Supply System Assembler
1031	Liquid Metal Supply System Repairer
1032	Liquid Metal Supply System Fault Identifier
1033	Materials Science C/D Equipment Deployer
1034	Materials Science C/D Equipment Module Remover
1035	Materials Science C/D Equipment Module Installer
1036	Materials Science C/D Equipment Disassembler
1037	Materials Science C/D Equipment Assembler
1038	Materials Science C/D Equipment Repairer
1039	Materials Science C/D Equipment Fault Identifier
1040	Materials Analysis Equipment Installer
1041	Materials Analysis Equipment Unstower
1042	Materials Analysis Equipment Translocator
1043	Materials Analysis Equipment Remover
1044	Materials Analysis Equipment Module Remover
1045	Materials Analysis Equipment Module Installer
*1046	Materials Analysis Equipment Calibrator
1047	Materials Analysis Equipment Stower
*1048	Materials Analysis Equipment Cleaner
*1049	Materials Analysis Equipment Controller
1050	Materials Analysis Equipment Disassembler

1051	Materials Analysis Equipment Assembler
1052	Materials Analysis Equipment Repairer
1053	Materials Analysis Equipment Fault Identifier
*1054	Computer Unstower
*1055	Computer Operation Monitor
1056	Computer Disassembler
1057	Computer Assembler
*1058	Environmental Chamber Unstower
*1059	Environmental Chamber Module Remover
*1060	Environmental Chamber Module Installer
*1061	Environmental Chamber Stower
*1062	Environmental Chamber Cleaner
1063	Environmental Chamber Disassembler
1064	Environmental Chamber Assembler
*1065	Environmental Chamber Repairer
*1066	Environmental Chamber Fault Identifier
*1067	Chill System Installer
*1068	Chill System Unstower
*1069	Chill System Translocator
*1070	Chill System Remover
1071	Chill System Module Remover
1072	Chill System Module Installer
*1073	Chill System Stower
*1074	Chill System Operation Monitor
1075	Chill System Disassembler
1076	Chill System Assembler
*1077	Chill System Repairer
*1078	Chill System Fault Identifier
*1079	Vibrator Installer
*1080	Vibrator Unstower
*1081	Vibrator Translocator
*1082	Vibrator Remover
1083	Vibrator Module Remover
1084	Vibrator Module Installer
*1085	Vibrator Stower
*1086	Vibrator Operation Monitor
1087	Vibrator Disassembler
1088	Vibrator Assembler
*1089	Vibrator Repairer
*1090	Vibrator Fault Identifier
*1091	VHF Power Unit Installer
*1092	VHF Power Unit Unstower
*1093	VHF Power Unit Translocator
*1094	VHF Power Unit Remover
*1095	VHF Power Unit Module Remover
*1096	VHF Power Unit Module Installer
*1097	VHF Power Unit Calibrator
*1098	VHF Power Unit Stower
*1099	VHF Power Unit Operation Monitor
1100	VHF Power Unit Disassembler



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1101-1150

1101	VHF Power Unit Assembler
*1102	VHF Power Unit Repairer
*1103	VHF Power Unit Fault Identifier
*1104	Telemetry Equipment Controller
*1105	Dispersion Control System Unstower
1106	Dispersion Control System Module Remover
*1107	Dispersion Control System Stower
1108	Dispersion Control System Module Installer
*1109	Dispersion Control System Cleaner
*1110	Dispersion Control System Operation Monitor
1111	Dispersion Control System Disassembler
1112	Dispersion Control System Assembler
*1113	Dispersion Control System Repairer
*1114	Dispersion Control System Fault Identifier
*1115	Slip Cast Injection System Installer
*1116	Slip Cast Injection System Unstower
*1117	Slip Cast Injection System Translocator
*1118	Slip Cast Injection System Remover
1119	Slip Cast Injection System Module Remover
1120	Slip Cast Injection System Module Installer
1121	Slip Cast Injection System Stower
*1122	Slip Cast Injection System Operation Monitor
1123	Slip Cast Injection System Disassembler
1124	Slip Cast Injection System Assembler
*1125	Slip Cast Injection System Repairer
*1126	Slip Cast Injection System Fault Identifier
*1127	Atmosphere Supply/Control System Module Remover
*1128	Atmosphere Supply/Control System Module Installer
*1129	Atmosphere Supply/Control System Operation Monitor
1130	Atmosphere Supply/Control System Disassembler
1131	Atmosphere Supply/Control System Assembler
*1132	Atmosphere Supply/Control System Repairer
*1133	Atmosphere Supply/Control System Fault Identifier
*1134	Power Conditioning/Distribution System Module Remover
*1135	Power Conditioning/Distribution System Module Installer
*1136	Power Conditioning/Distribution System Operation Monitor
1137	Power Conditioning/Distribution System Disassembler
1138	Power Conditioning/Distribution System Assembler
*1139	Power Conditioning/Distribution System Repairer
*1140	Power Conditioning/Distribution System Fault Identifier
*1141	Environmental Chamber Operation Monitor
*1142	Heat Rejection System Unstower
1143	Heat Rejection System Module Remover
1144	Heat Rejection System Module Installer
*1145	Heat Rejection System Stower
*1146	Heat Rejection System Operation Monitor
1147	Heat Rejection System Disassembler
1148	Heat Rejection System Assembler
*1149	Heat Rejection System Repairer
*1150	Heat Rejection System Fault Identifier

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #1151-1200

1151	Internal Attachments Installer
1152	Internal Attachments Unstower
1153	Internal Attachments Translocator
1154	Internal Attachments Remover
1155	Internal Attachments Stower
*1156	Data Recorder Installer
1157	Data Recorder Controller
1158	Photograph Enlarger Controller
1159	Photograph Printer Controller
*1160	Computer Stower
1161	Materials Science C/D Equipment Unstower
*1162	Atmosphere Supply/Control System Unstower
*1163	Power Conditioning/Distribution System Unstower
1164	Metal Foam Sample Unstower
1165	Metal Foam Sample Translocator
1166	Metal Foam Sample Installer
1167	Metal Foam Sample Remover
1168	Materials Science C/D Equipment Stower
*1169	Atmosphere Supply/Control System Stower
*1170	Power Conditioning/Distribution System Stower
1171	Metal Foam Sample Stower
1172	Materials Science C/D Equipment Control Actuator
*1173	Environmental Chamber Control Actuator
*1174	Atmosphere Supply/Control System Control Actuator
*1175	Furnace Control Actuator
*1176	Dispersion Control System Control Actuator
*1177	Mixing Unit Control Actuator
1178	Liquid Metal Supply System Control Actuator
*1179	Power Conditioning/Distribution System Control Actuator
1180	Mold Injection System Control Actuator
*1181	Chill System Control Actuator
*1182	Vibrator Control Actuator
*1183	VHF Power Unit Control Actuator
*1184	Heat Rejection System Control Actuator
1185	Metal Foam Structure Determiner
1186	Metal Foam Structure Analyzer
1187	Metal Foam Structure Evaluator
1188	Metal Foam Structure Test Report Preparer
1189	Metal Foam Research Planner
1190	Metal Foam Research Evaluator
1191	Workspace Equipment Unstower
1192	Workspace Equipment Stower
*1193	Telescope Repairer
*1194	TV System Repairer
*1195	Camera Repairer
1196	Grating Repairer
1197	Band Filter Repairer
1198	Metal Free Casting Research Planner
1199	Metal Free Casting Test Report Preparer
1200	Metal Free Casting Structure Determiner

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1201-1250

1201	Metal Free Casting Structure Analyzer
1202	Metal Free Casting Research Evaluator
*1203	Atmosphere Analysis Unit Unstower
*1204	Atmosphere Analysis Unit Translocator
*1205	Atmosphere Analysis Unit Installer
*1206	Atmosphere Analysis Unit Remover
*1207	Atmosphere Analysis Unit Stower
*1208	Atmosphere Analysis Unit Module Remover
*1209	Atmosphere Analysis Unit Module Installer
*1210	Atmosphere Analysis Unit Fault Identifier
*1211	Atmosphere Analysis Unit Repairer
1212	Atmosphere Analysis Unit Disassembler
1213	Atmosphere Analysis Unit Assembler
*1214	Atmosphere Analysis Unit Control Actuator
*1215	Viewing Device Unstower
*1216	Viewing Device Translocator
*1217	Viewing Device Installer
*1218	Viewing Device Remover
*1219	Viewing Device Stower
1220	Viewing Device Module Remover
1221	Viewing Device Module Installer
*1222	Viewing Device Fault Identifier
*1223	Viewing Device Repairer
1224	Viewing Device Disassembler
1225	Viewing Device Assembler
*1226	Camera Translocator
*1227	Holographic Device Calibrator
*1228	Holographic Device Operation Monitor
*1229	Holographic Device Control Actuator
1230	Holographic Device Assembler
1231	Holographic Device Disassembler
*1232	Holographic Device Repairer
*1233	Holographic Device Fault Identifier
*1234	Holographic Device Module Installer
*1235	Holographic Device Module Remover
*1236	Holographic Device Stower
*1237	Holographic Device Remover
*1238	Holographic Device Installer
*1239	Holographic Device Translocator
*1240	Holographic Device Unstower
*1241	Heating/Cooling Device Operation Monitor
*1242	Heating/Cooling Device Control Actuator
1243	Heating/Cooling Device Assembler
1244	Heating/Cooling Device Disassembler
*1245	Heating/Cooling Device Repairer
*1246	Heating/Cooling Device Fault Identifier
1247	Heating/Cooling Device Module Installer
1248	Heating/Cooling Device Module Remover
1249	Heating/Cooling Device Stower
*1250	Heating/Cooling Device Remover



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1251-1300

*1251 Heating/Cooling Device Installer
*1252 Heating/Cooling Device Translocator
*1253 Heating/Cooling Device Unstower
*1254 Metal Sample Installer
*1255 Metal Sample Remover
*1256 Metal Sample Translocator
*1257 Metal Sample Unstower
1258 Heating/Positioning Coil Controller
*1259 Heating/Positioning Coil Operation Monitor
*1260 Heating/Positioning Coil Control Actuator
1261 Heating/Positioning Coil Assembler
1262 Heating/Positioning Coil Disassembler
*1263 Heating/Positioning Coil Repairer
*1264 Heating/Positioning Coil Fault Identifier
1265 Heating/Positioning Coil Module Installer
1266 Heating/Positioning Coil Module Remover
*1267 Heating/Positioning Coil Stower
*1268 Heating/Positioning Coil Remover
*1269 Heating/Positioning Coil Installer
*1270 Heating/Positioning Coil Translocator
*1271 Heating/Positioning Coil Unstower
1272 Plasma Beam Unit Operation Monitor
1273 Plasma Beam Unit Control Actuator
1274 Plasma Beam Unit Assembler
1275 Plasma Beam Unit Disassembler
1276 Plasma Beam Unit Repairer
1277 Plasma Beam Unit Fault Identifier
1278 Plasma Beam Unit Module Installer
1279 Plasma Beam Unit Module Remover
1280 Plasma Beam Unit Stower
1281 Plasma Beam Unit Remover
1282 Plasma Beam Unit Installer
1283 Plasma Beam Unit Translocator
1284 Plasma Beam Unit Unstower
1285 Liquid Sphere Deployment System Operation Observer
1286 Liquid Sphere Deployment System Controller
1287 Liquid Sphere Deployment System Operation Monitor
1288 Liquid Sphere Deployment System Control Actuator
1289 Liquid Sphere Deployment System Assembler
1290 Liquid Sphere Deployment System Disassembler
1291 Liquid Sphere Deployment System Repairer
1292 Liquid Sphere Deployment System Fault Identifier
1293 Liquid Sphere Deployment System Module Installer
1294 Liquid Sphere Deployment System Module Remover
1295 Liquid Sphere Deployment System Stower
1296 Liquid Sphere Deployment System Remover
1297 Liquid Sphere Deployment System Installer
1298 Liquid Sphere Deployment System Translocator
1299 Liquid Sphere Deployment System Unstower
1300 Hollow Bodies Deployment System Controller

1301	Hollow Bodies Deployment System Operation Observer
1302	Hollow Bodies Deployment System Operation Monitor
1303	Hollow Bodies Deployment System Control Actuator
1304	Hollow Bodies Deployment System Assembler
1305	Hollow Bodies Deployment System Disassembler
1306	Hollow Bodies Deployment System Repairer
1307	Hollow Bodies Deployment System Fault Identifier
1308	Hollow Bodies Deployment System Module Installer
1309	Hollow Bodies Deployment System Module Remover
1310	Hollow Bodies Deployment System Stower
1311	Hollow Bodies Deployment System Remover
1312	Hollow Bodies Deployment System Installer
1313	Hollow Bodies Deployment System Translocator
1314	Hollow Bodies Deployment System Unstower
1315	Membrane Drawing Tool Controller
1316	Membrane Drawing Tool Operation Observer
1317	Membrane Drawing Tool Operation Monitor
1318	Membrane Drawing Tool Control Actuator
1319	Membrane Drawing Tool Assembler
1320	Membrane Drawing Tool Disassembler
1321	Membrane Drawing Tool Repairer
1322	Membrane Drawing Tool Fault Identifier
1323	Membrane Drawing Tool Module Installer
1324	Membrane Drawing Tool Module Remover
1325	Membrane Drawing Tool Stower
1326	Membrane Drawing Tool Remover
1327	Membrane Drawing Tool Installer
1328	Membrane Drawing Tool Translocator
1329	Membrane Drawing Tool Unstower
1330	Materials Science C/D Equipment Control Deactuator
1331	Heat Rejection System Remover
1332	Heat Rejection System Installer
*1333	Heating/Positioning Coil Calibrator
1334	Plasma Beam Unit Calibrator
1335	Membrane Drawing Tool Calibrator
*1336	Heating/Positioning Coil Cleaner
1337	Plasma Beam Unit Cleaner
1338	Liquid Sphere Deployment System Cleaner
1339	Hollow Bodies Deployment System Cleaner
1340	Membrane Drawing Tool Cleaner
*1341	Metal Sample Stower
1342	Heating/Positioning Coil Operation Observer
*1343	Atmosphere Analysis Unit Operation Monitor
*1344	Camera Operation Monitor
*1345	TV Camera Operation Monitor
*1346	Liquid Dispersion Research Planner
*1347	Slip Formulation Controller
*1348	Slip Materials Stower
1349	Materials Slip Mixing Controller
1350	Materials Slip Mold Opener

- *1351 Slip Materials Remover
- 1352 Materials Slip Drying Observer
- *1353 Liquid Dispersion Research Evaluator
- *1354 Materials Sample Unstower
- *1355 Materials Sample Translocator
- *1356 Materials Sample Installer
- *1357 Materials Sample Remover
- *1358 Slip Casting Remover
- *1359 Slip Casting Stower
- *1360 Immiscible System Casting Stower
- *1361 Slip Cast Injection System Cleaner
- *1362 Immiscible System Casting Remover
- *1363 Slip Cast Injection System Controller
- 1364 Mold Injection System Controller
- 1365 Immiscible System Dispersion Determiner
- *1366 Sample Holder Installer
- *1367 Crystal Growth Research Planner
- *1368 Crystal Growth Observer
- *1369 Crystal Growth Process Evaluator
- *1370 Materials Dopant Installer
- *1371 Materials Sample Stower
- *1372 Silicate Melt Susceptor Control Actuator
- *1373 Silicate Melt Susceptor Unstower
- *1374 Silicate Melt Susceptor Translocator
- *1375 Silicate Melt Susceptor Installer
- *1376 Silicate Melt Susceptor Remover
- *1377 Silicate Melt Susceptor Module Remover
- *1378 Silicate Melt Susceptor Module Installer
- 1379 Silicate Melt Susceptor Cleaner
- 1380 Seed Injector Control Actuator
- 1381 Seed Injector Unstower
- 1382 Seed Injector Translocator
- 1383 Seed Injector Installer
- 1384 Seed Injector Remover
- 1385 Seed Injector Module Remover
- 1386 Seed Injector Module Installer
- 1387 Seed Injector Cleaner
- 1388 Seed Injector Operation Monitor
- 1389 Seed Injector Disassembler
- 1390 Seed Injector Assembler
- 1391 Seed Injector Fault Identifier
- 1392 Seed Injector Repairer
- 1393 Teleoperator System Repairer
- *1394 Crystal Growth Research Evaluator
- *1395 Silicate Melt Susceptor Fault Identifier
- *1396 Silicate Melt Susceptor Repairer
- 1397 SITOS Fault Identifier
- *1398 Silicate Solvent Applier
- 1399 Data Recorder Control Actuator
- *1400 Furnace Control Deactuator

*1401	Silicate Melt Susceptor Operation Monitor
1402	Silicate Melt Susceptor Disassembler
1403	Silicate Melt Susceptor Assembler
1404	SITOS Repairer
*1405	Zone Melter Control Actuator
*1406	Zone Melter Unstower
*1407	Zone Melter Translocator
*1408	Zone Melter Installer
1409	Zone Melter Remover
*1410	Zone Melter Module Remover
*1411	Zone Melter Module Installer
*1412	Zone Melter Cleaner
*1413	Zone Melter Operation Monitor
1414	Zone Melter Disassembler
*1415	Crystal Puller Control Actuator
*1416	Crystal Puller Unstower
*1417	Crystal Puller Translocator
*1418	Crystal Puller Installer
*1419	Crystal Puller Remover
1420	Crystal Puller Module Remover
1421	Crystal Puller Module Installer
*1422	Crystal Puller Cleaner
*1423	Crystal Puller Operation Monitor
1424	Crystal Puller Disassembler
*1425	Zone Refiner Control Actuator
*1426	Zone Refiner Unstower
*1427	Zone Refiner Translocator
*1428	Zone Refiner Installer
1429	Zone Refiner Remover
*1430	Zone Refiner Module Remover
*1431	Zone Refiner Module Installer
*1432	Zone Refiner Cleaner
*1433	Zone Refiner Operation Monitor
1434	Zone Refiner Disassembler
1435	Zone Refiner Assembler
*1436	Zone Refiner Fault Identifier
*1437	Zone Refiner Repairer
1438	Zone Melter Assembler
*1439	Zone Melter Fault Identifier
*1440	Zone Melter Repairer
1441	Crystal Puller Assembler
*1442	Crystal Puller Fault Identifier
*1443	Crystal Puller Repairer
*1444	Crystal Growth Characteristics Determiner
*1445	Crystal Growth Structure Analyzer
*1446	Test Cell Installer
*1447	Materials Analysis Equipment Tester
*1448	Camera Tester
*1449	Holographic Device Tester
1450	Holographic Device Controller



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1451-1500

1451 Camera Timer Control Actuator
1452 Camera Timer Disassembler
1453 Crystal Growth Structure Evaluator
*1454 Crystal Growth Data Recorder
*1455 Densitometer Unstower
*1456 Densitometer Translocator
*1457 Densitometer Installer
*1458 Densitometer Remover
1459 Densitometer Module Remover
1460 Densitometer Module Installer
*1461 Densitometer Calibrator
*1462 Densitometer Operation Monitor
1463 Densitometer Disassembler
1464 Densitometer Assembler
*1465 Densitometer Fault Identifier
*1466 Densitometer Repairer
1467 Growth Tube Remover
1468 Growth Tube Controller
1469 Camera Timer Assembler
1470 Camera Timer Module Remover
1471 Camera Timer Module Installer
1472 Camera Timer Fault Identifier
1473 Camera Timer Repairer
*1474 Calorimeter Repairer
1475 Calorimeter Assembler
1476 Calorimeter Disassembler
1477 Calorimeter Module Installer
1478 Calorimeter Module Remover
*1479 Calorimeter Remover
*1480 Calorimeter Installer
*1481 Calorimeter Translocator
*1482 Calorimeter Unstower
*1483 Friction Measuring Device Repairer
*1484 Friction Measuring Device Fault Identifier
1485 Friction Measuring Device Assembler
1486 Friction Measuring Device Disassembler
*1487 Friction Measuring Device Operation Monitor
*1488 Friction Measuring Device Calibrator
1489 Friction Measuring Device Module Installer
1490 Friction Measuring Device Module Remover
*1491 Friction Measuring Device Remover
*1492 Friction Measuring Device Installer
*1493 Friction Measuring Device Translocator
*1494 Friction Measuring Device Unstower
*1495 Friction Measuring Device Control Deactuator
*1496 Friction Measuring Device Control Actuator
*1497 Friction Measuring Device Stower
*1498 Friction Measuring Device Cleaner
*1499 Calorimeter Stower
*1500 Calorimeter Cleaner

1501 Materials Science C/D Equipment Operation Monitor
1502 Atmosphere Supply/Control System Control Deactuator
1503 Environmental Chamber Control Deactuator
1504 Power Conditioning/Distribution System Control Deactuator
*1505 Heating/Positioning Coil Control Deactuator
1506 Zone Melter Control Deactuator
*1507 Atmosphere Analysis Unit Control Deactuator
*1508 Holographic Device Control Deactuator
*1509 VHF Power Unit Control Deactuator
1510 Heat Rejection System Control Deactuator
1511 Zone Melter Stower
*1512 Crystal Growth Process Monitor
*1513 Glass Samples Unstower
*1514 Glass Samples Translocator
*1515 Glass Samples Installer
*1516 Glass Samples Remover
*1517 Glass Samples Stower
*1518 Glass Structure Analyzer
*1519 Data Recorder Unstower
*1520 Data Recorder Translocator
*1521 Glass Processing Research Planner
*1522 Glass Processing Research Evaluator
1523 Glass Samples Observer
*1524 Gas Elimination/Cooling System Installer
*1525 Gas Elimination/Cooling System Unstower
*1526 Gas Elimination/Cooling System Translocator
*1527 Gas Elimination/Cooling System Cleaner
*1528 Gas Elimination/Cooling System Stower
*1529 Gas Elimination/Cooling System Operation Monitor
1530 Gas Elimination/Cooling System Disassembler
1531 Gas Elimination/Cooling System Assembler
1532 Gas Elimination/Cooling System Module Remover
1533 Gas Elimination/Cooling System Module Installer
*1534 Gas Elimination/Cooling System Fault Identifier
*1535 Gas Elimination/Cooling System Repairer
*1536 Cleanup/Refurbishment Equipment Installer
*1537 Cleanup/Refurbishment Equipment Unstower
*1538 Cleanup/Refurbishment Equipment Translocator
*1539 Cleanup/Refurbishment Equipment Stower
*1540 Buffer/Waste Separator Installer
*1541 Buffer/Waste Separator Unstower
*1542 Buffer/Waste Separator Translocator
*1543 Buffer/Waste Separator Cleaner
*1544 Buffer/Waste Separator Stower
*1545 Buffer/Waste Separator Operation Monitor
1546 Buffer/Waste Separator Disassembler
1547 Buffer/Waste Separator Assembler
*1548 Buffer/Waste Separator Fault Identifier
*1549 TV System Control Actuator
*1550 Data Compression Equipment Control Actuator

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1551-1600

*1551 Buffer Solution Installer
 *1552 Buffer Solution Unstower
 *1553 Buffer Solution Translocator
 *1554 Buffer Solution Remover
 *1555 Buffer Solution Mixing Controller
 *1556 Biological Materials Installer
 *1557 Biological Materials Unstower
 *1558 Biological Materials Translocator
 *1559 Biological Materials Remover
 *1560 Biological Enclosure Unstower
 1561 Biological Enclosure Cleaner
 *1562 Biological Enclosure Stower
 *1563 Biological Enclosure Operation Monitor
 1564 Biological Enclosure Disassembler
 1565 Biological Enclosure Assembler
 1566 Biological Enclosure Module Remover
 1567 Biological Enclosure Module Installer
 *1568 Biological Enclosure Fault Identifier
 *1569 Biological Enclosure Repairer
 1570 Buffer/Waste Separator Module Remover
 1571 Buffer/Waste Separator Module Installer
 *1572 Buffer/Waste Separator Repairer
 *1573 Electrophoretic Column Installer
 *1574 Electrophoretic Column Unstower
 *1575 Electrophoretic Column Translocator
 *1576 Electrophoretic Column Remover
 *1577 Electrophoretic Column Cleaner
 *1578 Electrophoretic Column Stower
 *1579 Electrophoretic Column Operation Monitor
 1580 Electrophoretic Column Disassembler
 1581 Electrophoretic Column Assembler
 1582 Electrophoretic Column Module Remover
 1583 Electrophoretic Column Module Installer
 *1584 Electrophoretic Column Fault Identifier
 *1585 Electrophoretic Column Repairer
 *1586 Electrophoretic Separation Research Planner
 *1587 Electrophoretic Separation Process Evaluator
 *1588 Electrophoretic Separation Data Recorder
 *1589 Lyophilization Apparatus Control Actuator
 1590 Lyophilization Apparatus Operation Monitor
 1591 Lyophilization Apparatus Disassembler
 1592 Lyophilization Apparatus Assembler
 1593 Lyophilization Apparatus Module Remover
 1594 Lyophilization Apparatus Module Installer
 1595 Lyophilization Apparatus Fault Identifier
 1596 Lyophilization Apparatus Repairer
 1597 Syringe Controller
 *1598 Ampoule Installer
 1599 Data Recorder Remover
 1600 Data Recorder Stower

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1601-1650

*1601 Interferometer Installer
 *1602 Interferometer Unstower
 *1603 Interferometer Translocator
 *1604 Interferometer Remover
 *1605 Interferometer Calibrator
 *1606 Interferometer Tester
 *1607 Interferometer Stower
 *1608 Interferometer Controller
 *1609 Interferometer Operation Monitor
 1610 Interferometer Disassembler
 1611 Interferometer Assembler
 1612 Interferometer Module Remover
 1613 Interferometer Module Installer
 *1614 Interferometer Fault Identifier
 *1615 Interferometer Repairer
 *1616 Interferometer Control Actuator
 *1617 Densitometer Control Actuator
 *1618 Densitometer Tester
 *1619 Densitometer Stower
 *1620 Densitometer Controller
 *1621 Buffer/Waste Separator Remover
 *1622 Gas Elimination/Cooling System Remover
 *1623 Buffer Solution Flow Rate Determiner
 *1624 Biological Materials Test Observer
 *1625 Electrophoretic Separation Research Evaluator
 *1626 Biological Materials Mixing Controller
 1627 Lyophilization Apparatus Unstower
 1628 Lyophilization Apparatus Translocator
 1629 Lyophilization Apparatus Installer
 1630 Lyophilization Apparatus Remover
 1631 Lyophilization Data Recorder
 1632 Lyophilization Research Planner
 1633 Biological Materials Culturing Controller
 1634 Isotope Tracer-Counter Unstower
 1635 Isotope Tracer-Counter Translocator
 1636 Isotope Tracer-Counter Installer
 1637 Isotope Tracer-Counter Remover
 1638 Isotope Tracer-Counter Module Remover
 1639 Isotope Tracer-Counter Module Installer
 1640 Isotope Tracer-Counter Calibrator
 1641 Isotope Tracer-Counter Operation Monitor
 1642 Isotope Tracer-Counter Controller
 1643 Isotope Tracer-Counter Disassembler
 1644 Isotope Tracer-Counter Assembler
 1645 Isotope Tracer-Counter Fault Identifier
 *1646 Isotope Tracer-Counter Repairer
 *1647 Fluid Sample Mixing Controller
 *1648 Fluid Convection Research Planner
 *1649 Fluid Convection Research Evaluator
 *1650 Fluid Samples Installer

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1651-1700

*1651 Fluid Samples Translocator
 *1652 Fluid Samples Unstower
 *1653 Fluid Samples Remover
 1654 Rotational Testing Device Unstower
 1655 Rotational Testing Device Translocator
 1656 Rotational Testing Device Assembler
 1657 Rotational Testing Device Installer
 1658 Rotational Testing Device Tester
 1659 Rotational Testing Device Remover
 1660 Rotational Testing Device Module Remover
 1661 Rotational Testing Device Module Installer
 1662 Rotational Testing Device Cleaner
 1663 Rotational Testing Device Stower
 1664 Rotational Testing Device Control Actuator
 1665 Rotational Testing Device Occupant
 1666 Rotational Testing Device Controller
 1667 Rotational Testing Device Calibrator
 1668 Rotational Testing Device Disassembler
 1669 Rotational Testing Device Fault Identifier
 1670 Rotational Testing Device Repairer
 1671 Protective Cover Remover
 1672 Protective Cover Translocator
 1673 Protective Cover Stower
 1674 Protective Cover Unstower
 1675 Protective Cover Installer
 1676 Biteboard Unstower
 1677 Biteboard Translocator
 1678 Biteboard Installer
 1679 Biteboard Remover
 1680 Biteboard Cleaner
 1681 Biteboard Stower
 1682 Cable Unstower
 1683 Cable Translocator
 1684 Cable Installer
 1685 Cable Remover
 1686 Accelerometer Unstower
 1687 Accelerometer Translocator
 1688 Accelerometer Installer
 1689 Accelerometer Tester
 1690 Accelerometer Remover
 1691 Accelerometer Cleaner
 1692 Accelerometer Stower
 1693 Accelerometer Fault Identifier
 1694 Accelerometer Repairer
 1695 Cable Tester
 1696 Data Recorder Tester
 1697 Data Recorder Disassembler
 1698 Data Recorder Assembler
 1699 Data Recorder Module Remover
 1700 Data Recorder Module Installer

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1701-1750

1701 Life Sciences C/D Equipment Unstower
1702 Life Sciences C/D Equipment Tester
1703 Life Sciences C/D Equipment Module Remover
1704 Life Sciences C/D Equipment Module Installer
1705 Life Sciences C/D Equipment Cleaner
1706 Life Sciences C/D Equipment Stower
1707 Life Sciences C/D Equipment Fault Identifier
1708 Life Sciences C/D Equipment Repairer
1709 Record Keeping Materials Unstower
1710 Record Keeping Materials Translocator
1711 Record Keeping Materials Stower
1712 Head Proximity Device Unstower
1713 Head Proximity Device Translocator
1714 Head Proximity Device Installer
1715 Head Proximity Device Tester
1716 Head Proximity Device Remover
1717 Head Proximity Device Module Remover
1718 Head Proximity Device Module Installer
1719 Head Proximity Device Cleaner
1720 Head Proximity Device Stower
1721 Head Proximity Device Disassembler
1722 Head Proximity Device Assembler
1723 Head Proximity Device Fault Identifier
1724 Head Proximity Device Repairer
1725 Vestibular Research Configuration Observer
1726 Vestibular Research Configuration Recorder
1727 Vestibular Research Data Recorder
1728 Vestibular Research Evaluator
1729 Vestibular Research Results Determiner
1730 Vestibular Research Planner
1731 Vestibular Research Observer
1732 Vestibular Research Results Communicator
1733 Data Management Unit Tester
1734 Data Management Unit Disassembler
1735 Data Management Unit Assembler
1736 Data Management Unit Module Remover
1737 Data Management Unit Module Installer
1738 Data Management Unit Fault Identifier
1739 Data Management Unit Repairer
1740 Human Subject Status Observer
1741 Human Subject Status Monitor
1742 RAM Surfaces Cleaner
1743 RAM Facility Equipment Cleaner
1744 Visual Target Observer
1745 Visual Target Evaluator
1746 Visual Target Status Communicator
1747 Canal Stimulation Symptoms Evaluator
1748 Canal Stimulation Symptoms Communicator
1749 Spatial Localization Success Evaluator
1750 Plethysmograph Installer

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1751-1800

1751	Plethysmograph Wearer
1752	Plethysmograph Unstower
1753	Plethysmograph Tester
1754	Plethysmograph Remover
1755	Plethysmograph Translocator
1756	Plethysmograph Stower
1757	Plethysmograph Operation Monitor
1758	Plethysmograph Disassembler
1759	Plethysmograph Assembler
1760	Plethysmograph Module Remover
1761	Plethysmograph Module Installer
1762	Plethysmograph Fault Identifier
1763	Plethysmograph Repairer
1764	Sphygmomanometer Installer
1765	Sphygmomanometer Wearer
1766	Sphygmomanometer Unstower
1767	Sphygmomanometer Translocator
1768	Sphygmomanometer Tester
1769	Sphygmomanometer Remover
1770	Sphygmomanometer Stower
1771	Sphygmomanometer Operation Monitor
1772	Sphygmomanometer Disassembler
1773	Sphygmomanometer Assembler
1774	Sphygmomanometer Module Remover
1775	Sphygmomanometer Module Installer
1776	Sphygmomanometer Fault Identifier
1777	Sphygmomanometer Repairer
1778	Electrocardiograph Installer
1779	Electrocardiograph Wearer
1780	Electrocardiograph Unstower
1781	Electrocardiograph Translocator
1782	Electrocardiograph Tester
1783	Electrocardiograph Remover
1784	Electrocardiograph Stower
1785	Electrocardiograph Operation Monitor
1786	Electrocardiograph Disassembler
1787	Electrocardiograph Assembler
1788	Electrocardiograph Module Remover
1789	Electrocardiograph Module Installer
1790	Electrocardiograph Fault Identifier
1791	Electrocardiograph Repairer
1792	LBNP Device Installer
1793	LBNP Device Wearer
1794	LBNP Device Unstower
1795	LBNP Device Translocator
1796	LBNP Device Tester
1797	LBNP Device Remover
1798	LBNP Device Stower
1799	LBNP Device Control Actuator
1800	LBNP Device Operation Monitor

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #1801-1850

1801	LBNP Device Disassembler
1802	LBNP Device Assembler
1803	LBNP Device Module Remover
1804	LBNP Device Module Installer
1805	LBNP Device Fault Identifier
1806	LBNP Device Repairer
1807	Body Temperature Measuring Device Installer
1808	Body Temperature Measuring Device Wearer
1809	Body Temperature Measuring Device Unstower
1810	Body Temperature Measuring Device Translocator
1811	Body Temperature Measuring Device Tester
1812	Body Temperature Measuring Device Remover
1813	Body Temperature Measuring Device Stower
1814	Body Temperature Measuring Device Operation Monitor
1815	Body Temperature Measuring Device Disassembler
1816	Body Temperature Measuring Device Assembler
1817	Body Temperature Measuring Device Module Remover
1818	Body Temperature Measuring Device Module Installer
1819	Body Temperature Measuring Device Fault Identifier
1820	Body Temperature Measuring Device Repairer
1821	Stowage Container Unstower
1822	Stowage Container Translocator
1823	Stowage Container Installer
1824	Stowage Container Remover
1825	Stowage Container Stower
1826	Life Sciences C/D Equipment Operation Monitor
1827	Cardioangiology Research Data Recorder
1828	Cardioangiology Research Planner
1829	Data Management Unit Control Actuator
1830	Cleaning/Decontamination Equipment Remover
1831	Electroanalytical System Cleaner
1832	Electroanalytical System Unstower
1833	Electroanalytical System Translocator
1834	Electroanalytical System Installer
1835	Electroanalytical System Tester
1836	Electroanalytical System Remover
1837	Electroanalytical System Module Remover
1838	Electroanalytical System Module Installer
1839	Electroanalytical System Stower
1840	Electroanalytical System Control Actuator
1841	Electroanalytical System Disassembler
1842	Electroanalytical System Assembler
1843	Electroanalytical System Fault Identifier
1844	Electroanalytical System Repairer
1845	Biomedical Fluid Transfer Equipment Cleaner
1846	Biomedical Fluid Transfer Equipment Unstower
1847	Biomedical Fluid Transfer Equipment Translocator
1848	Biomedical Fluid Transfer Equipment Installer
1849	Biomedical Fluid Transfer Equipment Remover
1850	Biomedical Fluid Transfer Equipment Stower

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1851-1900

1851	Photometer Cleaner
1852	Photometer Tester
1853	Photometer Remover
1854	Photometer Disassembler
1855	Photometer Assembler
1856	Photometer Fault Identifier
1857	Photometer Repairer
1858	Refractometer Cleaner
1859	Refractometer Unstower
1860	Refractometer Translocator
1861	Refractometer Installer
1862	Refractometer Tester
1863	Refractometer Remover
1864	Refractometer Module Remover
1865	Refractometer Module Installer
1866	Refractometer Stower
1867	Refractometer Control Actuator
1868	Refractometer Disassembler
1869	Refractometer Assembler
1870	Refractometer Fault Identifier
1871	Refractometer Repairer
1872	Centrifuge Cleaner
1873	Centrifuge Unstower
1874	Centrifuge Translocator
1875	Centrifuge Installer
1876	Centrifuge Tester
1877	Centrifuge Remover
1878	Centrifuge Module Remover
1879	Centrifuge Module Installer
1880	Centrifuge Stower
1881	Centrifuge Disassembler
1882	Centrifuge Assembler
1883	Centrifuge Fault Identifier
1884	Centrifuge Repairer
1885	Waste Management System Cleaner
1886	Waste Management System Unstower
1887	Waste Management System Tester
1888	Waste Management System Module Remover
1889	Waste Management System Module Installer
1890	Waste Management System Stower
1891	Waste Management System Disassembler
1892	Waste Management System Assembler
1893	Waste Management System Fault Identifier
1894	Waste Management System Repairer
1895	Syringe Unstower
1896	Syringe Translocator
1897	Syringe Installer
1898	Syringe Stower
1899	Biological Sample Container Unstower
1900	Biological Sample Container Translocator

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#1901-1950

1901	Biological Sample Container Installer
1902	Biological Sample Container Stower
1903	Freezer Unstower
1904	Freezer Tester
1905	Freezer Stower
1906	Freezer Disassembler
1907	Freezer Assembler
1908	Freezer Module Remover
1909	Freezer Module Installer
1910	Freezer Fault Identifier
1911	Freezer Repairer
1912	Timing Device Remover
1913	Timing Device Installer
1914	Timing Device Module Remover
1915	Timing Device Module Installer
1916	Timing Device Translocator
1917	Timing Device Stower
1918	Timing Device Unstower
1919	Timing Device Observer
1920	Timing Device Disassembler
1921	Timing Device Assembler
1922	Timing Device Fault Identifier
1923	Timing Device Repairer
1924	Timing Device Tester
1925	Body Waste Stower
1926	Body Waste Sample Remover
1927	Body Waste Sample Translocator
1928	Body Waste Sample Stower
1929	Body Waste Controller
1930	Body Waste Measurement Observer
1931	Body Waste Measurement Recorder
1932	Body Waste Sample Installer
1933	Gauze Sponge Stower
1934	Urology Research Data Recorder
1935	Urology Research Data Processor
1936	Urology Research Planner
1937	Record Keeping Materials Remover
1938	Blood Sample Remover
1939	Blood Sample Translocator
1940	Blood Sample Stower
1941	Blood Sample Donor
1942	Blood Sample Installer
1943	Blood Sample Measurement Observer
1944	Blood Sample Measurement Recorder
1945	Waste Management System Control Actuator
1946	Human Subject Injection Site Determiner
1947	Human Subject Withdrawal Site Determiner
1948	PAH Injection Receiver
1949	Urology Research Schedule Communicator
1950	Electrocardiograph Control Actuator

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #1951-2000

1951	Ergometer Control Actuator
1952	Ergometer Unstower
1953	Ergometer Translocator
1954	Ergometer Installer
1955	Ergometer Tester
1956	Ergometer Control Deactuator
1957	Ergometer Remover
1958	Ergometer Stower
1959	Ergometer Controller
1960	Ergometer Disassembler
1961	Ergometer Assembler
1962	Ergometer Module Remover
1963	Ergometer Module Installer
1964	Ergometer Fault Identifier
1965	Ergometer Repairer
1966	Life Sciences C/D Equipment Control Deactuator
1967	Life Sciences C/D Equipment Control Actuator
1968	Cardiotachometer Unstower
1969	Cardiotachometer Translocator
1970	Cardiotachometer Installer
1971	Cardiotachometer Tester
1972	Cardiotachometer Remover
1973	Cardiotachometer Stower
1974	Cardiotachometer Control Actuator
1975	Cardiotachometer Disassembler
1976	Cardiotachometer Assembler
1977	Cardiotachometer Module Remover
1978	Cardiotachometer Module Installer
1979	Cardiotachometer Fault Identifier
1980	Cardiotachometer Repairer
1981	Timing Device Control Actuator
1982	Exercise Conditioning Research Planner
1983	Exercise Conditioning Research Instruction Communicator
1984	Exercise Conditioning Research Data Recorder
1985	Human Subject Heart Rate Monitor
*1986	Atmosphere Supply/Control System Inspector
*1987	Atmosphere Supply/Control System Tester
1988	Atmosphere Supply/Control System Installer
1989	Atmosphere Supply/Control Research Data Communicator
1990	Atmosphere Supply/Control System Remover
1991	Atmosphere Supply/Control System Translocator
1992	Atmosphere Supply/Control Sample Stower
1993	Atmosphere Supply/Control Research Data Recorder
1994	Atmosphere Supply/Control System Problem Determiner
1995	Data Management Unit Operation Monitor
1996	EVA Suit Unstower
1997	EVA Suit Inspector
1998	EVA Suit Installer
1999	EVA Suit Umbilical Connector
2000	EVA Suit Cable Connector



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING #2001-2050

2001	EVA Suit Tester
2002	EVA Suit Remover
2003	EVA-Vehicle Intercom Communicator
2004	EVA Test Assembly Calibrator
2005	EVA Test Assembly Controller
2006	EVA Test Assembly Control Actuator
2007	EVA Test Assembly Control Deactuator
2008	EVA Test Assembly Cleaner
2009	EVA Test Assembly Assembler
2010	EVA Test Assembly Disassembler
2011	EVA Test Assembly Translocator
2012	EVA Test Assembly Module Remover
2013	EVA Test Assembly Module Installer
2014	EVA Test Assembly Remover
2015	EVA Test Assembly Installer
2016	EVA Suit Operating Status Monitor
2017	EVA Suit Research Debriefing Communicator
2018	EVA Suit Research Data Evaluator
2019	EVA Suit Cleaner
2020	EVA Suit Module Remover
2021	EVA Suit Module Installer
2022	EVA Suit Fault Identifier
2023	EVA Suit Repairer
2024	Biomedical Measurements Sensor Installer
2025	Biopack Unstower
2026	Biopack Installer
2027	Biopack Tester
2028	Biopack Remover
2029	Biopack Operating Status Monitor
2030	Biopack Research Debriefing Communicator
2031	Biopack Research Data Evaluator
2032	Biopack Cleaner
2033	Biopack Disassembler
2034	Biopack Assembler
2035	Biopack Module Remover
2036	Biopack Module Installer
2037	Biopack Fault Identifier
2038	Biopack Repairer
2039	Tether/Control Unit Control Actuator
2040	Spectrograph Remover
2041	Spectrograph Installer
2042	Comm/Nav C/D Equipment Self-Test Control Actuator
2043	Comm/Nav C/D Equipment Self-Test Display Monitor
2044	Lyophilization Research Evaluator
* 2045	TV Camera Mode Recorder
* 2046	Scanner Mode Recorder
* 2047	Radiometer Mode Recorder
* 2048	Polarimeter Mode Recorder
* 2049	Spectrometer Mode Recorder
* 2050	Camera Status Monitor

*2051 Time Elapsed Observer
 *2052 TV Camera Status Monitor
 *2053 Atmospheric Pollution Data Observer
 *2054 Water Pollution Data Observer
 *2055 Water Pollution Data Evaluator
 *2056 Atmospheric Pollution Data Evaluator
 *2057 Meteorological Conditions Evaluator
 *2058 Mission Events Evaluator
 *2059 TV System Inspector
 *2060 TV System Tester
 *2061 Scanner Tester
 *2062 Polarimeter Tester
 *2063 Polarimeter Aligner
 *2064 TV System Fault Identifier
 *2065 Earth Survey C/D Equipment Repairer
 *2066 Scanner Repairer
 *2067 Polarimeter Repairer
 *2068 TV System Control Deactuator
 2069 Not Assigned
 2070 Not Assigned
 2071 Not Assigned
 2072 Not Assigned
 2073 Not Assigned
 2074 Not Assigned
 2075 Not Assigned
 *2076 TV Data Classifier
 *2077 Scanner Data Classifier
 *2078 Radiometer Data Classifier
 *2079 Polarimeter Data Classifier
 *2080 Spectrometer Data Classifier
 *2081 Polarimeter Controller
 *2082 TV Data Analyzer
 *2083 Scanner Data Analyzer
 *2084 Radiometer Data Analyzer
 *2085 Polarimeter Data Analyzer
 *2086 Spectrometer Data Analyzer
 *2087 Telescope Data Analyzer
 *2088 Scanner Adequacy Determiner
 *2089 TV Camera Adequacy Determiner
 *2090 Radiometer Adequacy Determiner
 *2091 Polarimeter Adequacy Determiner
 *2092 Telescope Adequacy Determiner
 *2093 Camera Adequacy Determiner
 *2094 TV System Operation Monitor
 *2095 Scanner Operation Monitor
 *2096 Radiometer Operation Monitor
 *2097 Polarimeter Operation Monitor
 *2098 Spectrometer Operation Monitor
 *2099 Telescope Operation Monitor
 *2100 Atmospheric Pollution Data Classifier

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#2101-2150

- * 2101 Water Pollution Data Classifier
- * 2102 Video Data Quality Evaluator
- * 2103 Radar Transmitter Mode Monitor
- * 2104 Radar Receiver Mode Monitor
- * 2105 Radar Transmitter Mode Recorder
- * 2106 Radar Receiver Mode Recorder
- * 2107 Land Use Data Observer
- * 2108 Land Use Data Evaluator
- * 2109 Radar Data Classifier
- * 2110 Telescope Data Classifier
- * 2111 Spectrometer Adequacy Determiner
- * 2112 Radar Transmitter Adequacy Determiner
- * 2113 Radar Receiver Adequacy Determiner
- * 2114 Radar Operation Monitor
- * 2115 Land Use Data Classifier
- * 2116 Earth Surface Landmark Observer
- * 2117 Earth Surface Landmark Classifier
- * 2118 Sferics Detector Mode Monitor
- * 2119 Sferics Detector Mode Recorder
- * 2120 Camera Mode Recorder
- * 2121 Geological Precursor Data Observer
- * 2122 Geological Precursor Data Evaluator
- * 2123 Earthquake Data Observer
- * 2124 Earthquake Data Evaluator
- * 2125 Sferics Detector Tester
- * 2126 Telescope Tester
- * 2127 Sferics Detector Adequacy Determiner
- * 2128 Meteorological Precursor Data Observer
- * 2129 Artificial Precursor Data Observer
- * 2130 Topographical Precursor Data Observer
- * 2131 Precursor Disaster Data Observer
- * 2132 Meteorological Precursor Data Evaluator
- * 2133 Artificial Precursor Data Evaluator
- * 2134 Topographical Precursor Data Evaluator
- * 2135 Precursor Disaster Data Evaluator
- * 2136 Hurricane Data Observer
- * 2137 Tornado Data Observer
- * 2138 Tidal Wave Data Observer
- * 2139 Flood Data Observer
- * 2140 Volcanic Eruption Data Observer
- * 2141 Forest Fire Data Observer
- * 2142 Range Fire Data Observer
- * 2143 Landslide Data Observer
- * 2144 Snowslide Data Observer
- * 2145 Land Subsidence Data Observer
- * 2146 Drought Data Observer
- * 2147 Blizzard Data Observer
- * 2148 Hurricane Data Evaluator
- * 2149 Tornado Data Evaluator
- * 2150 Tidal Wave Data Evaluator

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#2151-2200

- * 2151 Flood Data Evaluator
- * 2152 Volcanic Eruption Data Evaluator
- * 2153 Forest Fire Data Evaluator
- * 2154 Range Fire Data Evaluator
- * 2155 Landslide Data Evaluator
- * 2156 Snowslide Data Evaluator
- * 2157 Land Subsidence Data Evaluator
- * 2158 Drought Data Evaluator
- * 2159 Blizzard Data Evaluator
- * 2160 Geological Precursor Observer
- * 2161 Meteorological Precursor Observer
- * 2162 Artificial Precursor Observer
- * 2163 Topographical Precursor Observer
- * 2164 Precursor Disaster Observer
- * 2165 Geological Precursor Classifier
- * 2166 Meteorological Precursor Classifier
- * 2167 Artificial Precursor Classifier
- * 2168 Topographical Precursor Classifier
- * 2169 Precursor Disaster Classifier
- * 2170 Sferics Detector Data Classifier
- * 2171 Earthquake Disaster Predictor
- * 2172 Hurricane Disaster Predictor
- * 2173 Tornado Disaster Predictor
- * 2174 Tidal Wave Disaster Predictor
- * 2175 Flood Disaster Predictor
- * 2176 Volcanic Eruption Disaster Predictor
- * 2177 Forest Fire Disaster Predictor
- * 2178 Range Fire Disaster Predictor
- * 2179 Landslide Disaster Predictor
- * 2180 Snowslide Disaster Predictor
- * 2181 Land Subsidence Disaster Predictor
- * 2182 Drought Disaster Predictor
- * 2183 Blizzard Disaster Predictor
- * 2184 TV Camera Mode Selector
- * 2185 Radar Receiver Operation Monitor
- * 2186 Sferics Detector Operation Monitor
- * 2187 Recorder Control Actuator
- * 2188 Geological Precursor Data Classifier
- * 2189 Meteorological Precursor Data Classifier
- * 2190 Artificial Precursor Data Classifier
- * 2191 Topographical Precursor Data Classifier
- * 2192 Precursor Disaster Data Classifier
- * 2193 Earthquake Data Classifier
- * 2194 Hurricane Data Classifier
- * 2195 Tornado Data Classifier
- * 2196 Tidal Wave Data Classifier
- * 2197 Flood Data Classifier
- * 2198 Volcanic Eruption Data Classifier
- * 2199 Forest Fire Data Classifier
- * 2200 Range Fire Data Classifier



FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#2201-2250

- * 2201 Landslide Data Classifier
- * 2202 Snowslide Data Classifier
- * 2203 Land Subsidence Data Classifier
- * 2204 Drought Data Classifier
- * 2205 Blizzard Data Classifier
- * 2206 Geological Precursor Communicator
- * 2207 Meteorological Precursor Communicator
- * 2208 Artificial Precursor Communicator
- * 2209 Topographical Precursor Communicator
- * 2210 Precursor Disaster Communicator
- * 2211 Earthquake Disaster Communicator
- * 2212 Hurricane Disaster Communicator
- * 2213 Tornado Disaster Communicator
- * 2214 Tidal Wave Disaster Communicator
- * 2215 Flood Disaster Communicator
- * 2216 Volcanic Eruption Disaster Communicator
- * 2217 Forest Fire Disaster Communicator
- * 2218 Range Fire Disaster Communicator
- * 2219 Landslide Disaster Communicator
- * 2220 Snowslide Disaster Communicator
- * 2221 Land Subsidence Disaster Communicator
- * 2222 Drought Disaster Communicator
- * 2223 Blizzard Disaster Communicator
- * 2224 Earthquake Disaster Identifier
- * 2225 Hurricane Disaster Identifier
- * 2226 Tornado Disaster Identifier
- * 2227 Tidal Wave Disaster Identifier
- * 2228 Flood Disaster Identifier
- * 2229 Volcanic Eruption Disaster Identifier
- * 2230 Range Fire Disaster Identifier
- * 2231 Landslide Disaster Identifier
- * 2232 Snowslide Disaster Identifier
- * 2233 Land Subsidence Disaster Identifier
- * 2234 Drought Disaster Identifier
- * 2235 Blizzard Disaster Identifier
- * 2236 Telescope Data Quality Monitor
- * 2237 Sferics Detector Repairer
- * 2238 Biological Materials Separation Planner
- * 2239 Electrophoretic Separation Research Coordinator
- * 2240 Instrumentation & Control Center Unstower
- * 2241 Ampoule Remover
- * 2242 Densitometer Inspector
- * 2243 Interferometer Inspector
- * 2244 Buffer Solution Stower
- * 2245 Biological Materials Stower
- * 2246 Instrumentation & Control Center Stower
- * 2247 Buffer Solution Flow Rate Observer
- * 2248 Electrophoretic Column Control Actuator
- * 2249 Biological Materials Data Determiner
- * 2250 Instrumentation & Control Center Fault Identifier

FLIGHT EXPERIMENT TASK-SKILLS - NUMERICAL LISTING

#2251-2300

- * 2251 Instrumentation & Control Center Repairer
- * 2252 General Purpose Lab Bench Unstower
- * 2253 Accident Control System Unstower
- * 2254 Glass Processing Research Coordinator
- * 2255 Instrumentation & Control Center Control Actuator
- * 2256 General Purpose Lab Bench Stower
- * 2257 Silicate Melt Susceptor Stower
- * 2258 Accident Control System Stower
- * 2259 Line Reader Installer
- * 2260 General Purpose Lab Bench Control Actuator
- * 2261 Accident Control System Control Actuator
- * 2262 Viewing Device Control Actuator
- * 2263 Glass Processing Research Monitor
- * 2264 Accident Control System Operation Monitor
- * 2265 General Purpose Lab Bench Fault Identifier
- * 2266 General Purpose Lab Bench Repairer
- * 2267 Accident Control System Fault Identifier
- * 2268 Accident Control System Repairer
- * 2269 Materials Analysis Equipment Inspector
- * 2270 Holographic Device Inspector
- * 2271 Environmental Chamber Inspector
- * 2272 Power Conditioning/Distribution System Inspector
- * 2273 Calorimeter Inspector
- * 2274 Friction Measuring Device Inspector
- * 2275 Atmosphere Analysis Unit Inspector
- * 2276 Chill System Inspector
- * 2277 Heat Rejection System Inspector
- * 2278 Heating/Positioning Coils Inspector
- * 2279 Viewing Device Inspector
- * 2280 VHF Power Unit Inspector
- * 2281 Accident Control System Inspector
- * 2282 General Purpose Lab Bench Inspector
- * 2283 Environmental Chamber Tester
- * 2284 Power Conditioning/Distribution System Tester
- * 2285 Calorimeter Tester
- * 2286 Friction Measuring Device Tester
- * 2287 Atmosphere Analysis Unit Tester
- * 2288 Chill System Tester
- 2289 Not Assigned
- * 2290 Heat Rejection System Tester
- * 2291 Heating/Positioning Coil Tester
- * 2292 Viewing Device Tester
- * 2293 VHF Power Unit Tester
- * 2294 Accident Control System Tester
- * 2295 Computer Tester
- * 2296 Viewing Device Control Deactuator
- * 2297 Chill System Control Deactuator
- * 2298 Crystal Growth Research Coordinator
- * 2299 Crystal Growth Process Observer
- * 2300 Materials Sample Structure Analyzer

- * 2301 Metal Sample Structure Analyzer
- * 2302 Glass Sample Structure Analyzer
- * 2303 Crystal Growth Research Monitor
- * 2304 Materials Dopant Translocator
- * 2305 Materials Dopant Unstower
- * 2306 Heating/Cooling Device Cleaner
- * 2307 Heating/Cooling Device Control Deactuator
- * 2308 Sample Holder Remover
- * 2309 Composite Materials Research Coordinator
- * 2310 Dispersion Control System Translocator
- * 2311 Dispersion Control System Installer
- * 2312 Dispersion Control System Remover
- * 2313 Dispersion Control System Calibrator
- * 2314 Composite Materials Sample Evaluator
- * 2315 Composite Materials Research Monitor
- * 2316 Immiscible Liquid Sample Remover
- * 2317 Immiscible Liquid Sample Installer
- * 2318 Slip Casting Translocator
- * 2319 Immiscible System Casting Translocator
- * 2320 Liquid Dispersions Research Coordinator
- * 2321 Mixing Equipment Controller
- * 2322 Slip Materials Installer
- * 2323 Casting Mold Disassembler
- * 2324 Casting Mold Installer
- * 2325 Liquid Dispersion Research Status Determiner
- * 2326 Liquid Dispersion Research Monitor
- * 2327 Slip Cast Injection System Control Actuator
- * 2328 Fluid Connection Research Coordinator
- * 2329 Fluid Connection Research Monitor
- * 2330 Test Cell Translocator
- * 2331 Test Cell Unstower
- * 2332 Peltier Heater Control Actuator
- * 2333 Crystal Growth Data Observer
- * 2334 Crystal Growth Data Interpreter
- * 2335 Crystal Sample Installer
- * 2336 Microscope Controller
- * 2337 Zone Melter Controller

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

**APPENDIX F
OCCUPATIONAL SKILL DESCRIPTIONS**



APPENDIX F

Occupational Skill Descriptions

The methodology used in skill definition for orbital research experiments involved translation of task-skills, determined for each identified combination of task dependencies and crew functions, into standardized occupational skill categories. As explained in Section 2.0 of the report, the Dictionary of Occupational Skills, by the U.S. Department of Labor (References 20 and 21, Appendix A) was used as the source of standardized skill classifications, as well as the method of classification.

The following pages of this Appendix represent a composite of excerpts from the Dictionary, presenting in numerical order by code number, the Occupational Skill Descriptions for the Primary Occupational Skills and the Mission Occupational Skills selected during this study. At the top of each page is the six-digit classification code and the major title for the selected occupation encompassed by that title. In some cases, specialty areas within that major title are also included (under the same classification code), whether or not that specialty was encompassed by the study.

The lower portion of the page presents information of a general nature about the occupation, described partly by the last three digits of the classification code and partly by the type of work requiring that occupation. A detailed description of the method will be found in the Dictionary.

The "Qualifications Profile" which is part of each description includes a number of abbreviations and code designations, explained as follows:

- GED: General Educational Development. Number codes are on a scale of one (1) through six (6) and relate to increasing development levels covering reasoning ability, mathematical capability, and language development.
- SVP: Specific Vocational Preparation. This includes training given in any of the following circumstances:
 - a. Vocational education (such as high school commercial or shop training, technical school; art school; and that part of college training which is organized around a specific vocational objective);
 - b. Apprentice training (for apprenticeable jobs only);
 - c. In-plant training (given by an employer in the form of organized classroom study);
 - d. On-the-job training (serving as learner or trainee on the job under the instruction of a qualified worker);
 - e. Essential experience in other jobs (serving in less responsible jobs which lead to the higher grade job or serving in other jobs which qualify).



The following is an explanation of the various levels of specific vocational preparation.

Level	Time
1	Short demonstration only.
2	Anything beyond short demonstration up and including 30 days.
3	Over 30 days up to and including 3 months.
4	Over 3 months up to and including 6 months.
5	Over 6 months up to and including 1 year.
6	Over 1 year up to and including 2 years.
7	Over 2 years up to and including 4 years.
8	Over 4 years up to and including 10 years.
9	Over 10 years.

• Apt.: Aptitudes. Letter codes have the following meanings.

G: Intelligence
V: Verbal
N: Numerical
S: Spatial
P: Form Perception
Q: Clerical Perception
K: Motor Coordination
F: Finger Dexterity
M: Manual Dexterity
E: Eye-Hand-Foot Coordination
C: Color Discrimination

The following scale is used under each aptitude letter code:

- 1 The top 10 percent of the population. This segment of the population possesses an extremely high degree of the aptitude.
- 2 The highest third exclusive of the top 10 percent of the population. This segment of the population possesses an above average or high degree of the aptitude.
- 3 The middle third of the population. This segment of the population possesses a medium degree of the aptitude, ranging from slightly below to slightly above average.
- 4 The lowest third exclusive of the bottom 10 percent of the population. This segment of the population possesses a below average or low degree of the aptitude.
- 5 The lowest 10 percent of the population. This segment of the population possesses a negligible degree of the aptitude.

Certain aptitudes appear in boldface type on the qualifications profiles for the worker-trait groups. These aptitudes are considered to be occupationally significant for the specific group; i.e., essential for average successful job performance. All boldface aptitudes are not necessarily required of a worker for each individual job within a worker trait group, but some combination of them is essential in every case.

- Int.: Interests. Preferences for certain types of work activities or experiences, with accompanying rejection of contrary types of activities or experiences. Five pairs of interest factors are provided so that a positive preference for one factor of a pair also implies rejection of the other factor of that pair.

- | | | |
|---|-----|---|
| 1 Situations involving a preference for activities dealing with things and objects. | vs. | 6 Situations involving a preference for activities concerned with people and the communication of ideas. |
| 2 Situations involving a preference for activities involving business contact with people. | vs. | 7 Situations involving a preference for activities of a scientific and technical nature. |
| 3 Situations involving a preference for activities of a routine, concrete, organized nature. | vs. | 8 Situations involving a preference for activities of an abstract and creative nature. |
| 4 Situations involving a preference for working for people for their presumed good, as in the social welfare sense, or for dealing with people and language in social situations. | vs. | 9 Situations involving a preference for activities that are nonsocial in nature, and are carried on in relation to processes, machines, and techniques. |
| 5 Situations involving a preference for activities resulting in prestige or the esteem of others. | vs. | 0 Situations involving a preference for activities resulting in tangible, productive satisfaction. |

- Temp: Temperaments. Different types of occupational situations to which workers must adjust.

- 1 Situations involving a variety of duties often characterized by frequent change.
- 2 Situations involving repetitive or short cycle operations carried out according to set procedures or sequences.
- 3 Situations involving doing things only under specific instruction, allowing little or no room for independent action or judgment in working out job problems.
- 4 Situations involving the direction, control, and planning of an entire activity or the activities of others.
- 5 Situations involving the necessity of dealing with people in actual job duties beyond giving and receiving instructions.

- 6 Situations involving working alone and apart in physical isolation from others, although the activity may be integrated with that of others.
- 7 Situations involving influencing people in their opinions, attitudes, or judgments about ideas or things.
- 8 Situations involving performing adequately under stress when confronted with the critical or unexpected or when taking risks.
- 9 Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against sensory or judgmental criteria.
- 0 Situations involving the evaluation (arriving at generalizations, judgments, or decisions) of information against measurable or verifiable criteria.
- X Situations involving the interpretation of feelings, ideas, or facts in terms of personal viewpoint.
- Y Situations involving the precise attainment of set limits, tolerances, or standards.

• Phys. Dem.: Physical Demands.

- 1 Lifting, carrying, pushing, and/or pulling (strength) with the following subcodes.

S: Sedentary Work
 L: Light Work
 M: Medium Work
 H: Heavy Work
 V: Very Heavy Work

- 2 Climbing and/or balancing
- 3 Stooping, kneeling, crouching, and/or crawling
- 4 Reaching, handling, fingering, and/or feeling
- 5 Talking and/or hearing
- 6 Seeing

Occupational Skill descriptions are included for the following occupational classifications:

003.181 Electrical Technician
 003.187 Radio Engineer
 003.187 Systems Engineer, EDP
 003.281 Instrumentation Technician
 007.081 Optical Technician
 011.281 Metallurgist Assistant
 018.188 Surveyor, Geodetic
 022.081 Chemist, Inorganic
 022.081 Chemist, Physical
 023.081 Physicist, Heat
 024.081 Geologist
 024.081 Geophysicist
 025.088 Meteorologist

025.288 Weather Observer
041.081 Biochemist
710.884 Calibrator
714.684 Camera Inspector
722.281 Inspector, Systems
828.281 Electronics Mechanic

Descriptions of two other skill categories (000.000, General Technical Skill; xxx.xxx, Special Spaceflight Skill) are not included herein, because they are not included in the Dictionary. The origin and the application of these two titles are explained in Section 3.0 of the report.



003.181 ELECTRICAL TECHNICIAN (profess. & kin.)

JOB DEFINITION: Electric-laboratory technician. Applies electrical theory and related subjects to test and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial or commercial plants and laboratories: Assembles and tests experimental motor-control devices, switch panels, transformers, generator windings, solenoids, and other electrical equipment and components, according to engineering data and knowledge of electrical principles. Modifies electrical prototypes to correct functional deviations under direction of ELECTRICAL ENGINEER. Diagnoses cause of electrical or mechanical malfunction or failure of operational equipment and performs preventative and corrective maintenance. Develops wiring diagrams, layout drawings, and engineering specifications for system or equipment modifications or expansion, and directs personnel performing routine installation and maintenance duties. Plans, directs, and records periodic electrical testing, and recommends or initiates modification or replacement of equipment which fails to meet acceptable operating standards.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: TECHNICAL WORK, ENGINEERING AND RELATED FIELDS (.181; .281)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering-related and technical knowledge in direct support of the engineer. Typically, tasks performed are functional parts of engineering activities requiring the practical application of fundamental theory in such specialized areas as research, design, and development.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply basic engineering and technical principles and methods; facility with mathematics and language; and spacial perception.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Success in vocational and mathematical courses in high school.
- Interest in current technological developments.
- Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: Graduation from a technical institute or the completion of specialized programs in junior colleges or universities is usually required for entry into this field. A worker who has acquired the necessary knowledge of mathematics through apprenticeship or related programs also may find entry into this field.

RELATED CLASSIFICATIONS

Technical Work, Science and Related Fields (.384)
Materials Analysis and Related Work (.181; .281; .381)
Drafting and Related Work (.181; .281)
Engineering and Related Work (.187)

QUALIFICATIONS PROFILE*

GED: 4 5
SVP: 6 7
Apt: G V N S P Q K F M E C
2 2 2 2 2 3 2 2 2 3 3
3 3 3 3 3 3 3 3 3 4 4
Int: 7 9
Temp: Y 0
Phys. Dem: S L M 4 5 6

*For explanation, see page F-1



003.187 RADIO ENGINEER (radio & TV broad.)

JOB DEFINITION: Engineer, chief; engineer-in-charge; radio operator, chief; station engineer; technician, senior. Operates and maintains station audio and video transmission equipment in compliance with federal regulations; Diagnoses cause for malfunctions and oversees workers in adjusting and repairing station technical equipment. Tunes transmitter for most efficient operation. Oversees TRANSMITTER OPERATORS and instructs them in new operating methods.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: ENGINEERING AND RELATED WORK (.187)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering knowledge to the planning, direction, and installation of projects and systems. Typically, workers are concerned with a specific field of engineering, such as civil engineering, mechanical engineering, and electrical engineering.

WORKER REQUIREMENTS: An occupationally significant combination of: Organizational ability; clear verbal expression; ability to learn and apply engineering principles and methods; spatial and form perception; and facility with mathematics.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed interest in industrial developments.
- Success in pertinent academic subjects, such as mathematics.
- Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: A bachelor's degree in engineering is usually the minimum educational requirement for entrance into this field, and many employers are now requiring a graduate degree in engineering.

RELATED CLASSIFICATIONS:

Industrial Engineering and Related Work (.188; .288)
Engineering Research and Design (.081)
Technical Work, Engineering and Related Fields
 (.181; .281)
Engineering, Scientific, and Technical Coordination
 (.168)
Technical Writing and Related Work (.188; .288)
Drafting and Related Work (.181; .281)

QUALIFICATIONS PROFILE*

GED: 6 5
SVP: 8 7
Apt: G V N S P Q K F M E C
 1 1 1 2 2 4 4 4 4 5 5
 2 2 2 3 3
Int: 1 7 9
Temp: 4 0 Y
Phys. Dem: S L 6

*For explanation, see page F-1

003.187 SYSTEMS ENGINEER, ELECTRONIC DATA PROCESSING (profess. & kin.)

JOB DEFINITION: Computer systems engineer; methods analyst, electronic data processing. Analyzes electronic data processing projects to determine equipment requirements: Confers with MANAGER, ELECTRONIC DATA PROCESSING, concerning availability and capabilities of equipment in current use, and with PROJECT DIRECTOR, BUSINESS DATA PROCESSING, to specify computer system requirements for projects. Analyzes capabilities and limitations of computers and peripheral equipment, such as data recording, communication, input, output, and synchronizing (buffering) devices, in order to recommend most feasible new equipment or equipment modifications. Plans layout of computers and peripheral equipment to achieve efficient operation and effective use of assigned space. May specify power supply requirements and configuration and recommend purchase and arrangement of air conditioning equipment to control temperature, humidity, and dust. May specialize in one area of equipment application or in one make or type of equipment. Usually is employed as representative of consulting firm or equipment manufacturer.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: ENGINEERING AND RELATED WORK (.187)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering knowledge to the planning, direction, and installation of projects and systems. Typically, workers are concerned with a specific field of engineering, such as civil engineering, mechanical engineering, and electrical engineering.

WORKER REQUIREMENTS: An occupationally significant combination of: Organizational ability; clear verbal expression; ability to learn and apply engineering principles and methods; spatial and form perception; and facility with mathematics.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed interest in industrial developments.
- Success in pertinent academic subjects, such as mathematics.
- Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: A bachelor's degree in engineering is usually the minimum educational requirement for entrance into this field, and many employers are now requiring a graduate degree in engineering.

RELATED CLASSIFICATIONS:

Industrial Engineering and Related Work (.188; .288)
 Engineering Research and Design (.081)
 Technical Work, Engineering and Related Fields
 (.181; .281)
 Engineering, Scientific, and Technical Coordination
 (.168)
 Technical Writing and Related Work (.188; .288)
 Drafting and Related Work (.181; .281)

QUALIFICATIONS PROFILE*

GED: 6 5
 SVP: 8 7
 Apt: G V H S P Q K F M E C
 1 1 1 2 2 4 4 4 4 5 5
 2 2 2 3 3
 Int: 1 7 9
 Temp: 4 0 Y
 Phys. Dem: S L 6

*For explanation, see page F-1



003.281 INSTRUMENTATION TECHNICIAN (profess. & kin.)

JOB DEFINITION: Devises, sets up, and operates electronic instrumentation and related electromechanical or electrohydraulic apparatus involved in operational and environmental testing of mechanical, structural, or electrical equipment, and translates test data for subsequent use by engineering personnel in making engineering design and evaluation decisions. Selects, installs, calibrates, and checks out sensing, telemetering, and recording instrumentation and circuitry, and develops specifications for nonstandard apparatus according to engineering data, characteristics of equipment under test, and capabilities of procurable test apparatus. Sketches and builds or modifies jigs, fixtures, instruments, and related apparatus, and verifies dimensional and functional acceptability of devices fabricated by craft or technical personnel. Performs preventive and corrective maintenance of test apparatus and peripheral equipment. Directs technical personnel in installation of object in test chamber of other test facility. Operates test apparatus during test cycle to produce, regulate, and record effects of actual or simulated conditions, such as vibration, stress, temperature, humidity, pressure, altitude, and acceleration. Mathematically reduces test data to usable form, and prepares graphs and written reports to translate test results into meaningful terms such as speed-temperature-horsepower ratios. May plan complete test program. May be designated according to equipment tested as ROCKET-CONTROL TECHNICIAN, or according to nature of test as ENVIRONMENTAL-RESEARCH-TEST TECHNICIAN.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: TECHNICAL WORK, ENGINEERING AND RELATED FIELDS (.181; .281)

WORK PERFORMED: Work activities in this group primarily involve the application of engineering related and technical knowledge in direct support of the engineer. Typically, tasks performed are functional parts of engineering activities requiring the practical application of fundamental theory in such specialized areas as research, design, and development.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply basic engineering and technical principles and methods; facility with mathematics and language; and spatial perception.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Success in vocational and mathematical courses in high school.
- Interest in current technological developments.
- Subscriptions to engineering and technical magazines.

TRAINING AND METHODS OF ENTRY: Graduation from a technical institute or the completion of specialized programs in junior colleges or universities is usually required for entry into this field. A worker who has acquired the necessary knowledge of mathematics through apprenticeship or related programs also may find entry into this field.

RELATED CLASSIFICATIONS:

Technical Work, Science and Related Fields (.384)
Materials Analysis and Related Work (.181; .281; .381)
Drafting and Related Work (.181; .281)
Engineering and Related Work (.187)

QUALIFICATIONS PROFILE*

GED:	4	5					
SVP:	6	7					
Apt:	G	V	N	S	P	Q	K F M E C
	2	2	2	2	2	3	3 3
	3	3	3	3	3	3	3 3 4 4
Int:	7	9					
Temp:	Y	0					
Phys. Dem:	S	L	M	4	5	6	

*For explanation, see page F-1



007.081 OPTICAL TECHNICIAN (optical goods) I

JOB DEFINITION: Designs mechanical portion of precision optical instruments, such as aerial cameras, spectrophotometers, and refractometers; Reviews optical specifications to determine types of mounts, test lenses, tools, and fixtures required, and sequence of operations necessary for construction of optical system. Draws sketches of mechanical parts, such as retaining rings, diaphragms, and barrel mounts, following blueprints and work orders. Devises equipment for testing optical system. Tests system to determine working characteristics and conformance to specifications, using standard and modified optical test equipment and procedures. May assemble optical and mechanical elements to construct instruments, using handtools.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: ENGINEERING RESEARCH AND DESIGN (.081)

WORK PERFORMED: Work activities in this group primarily involve using and adapting earth substances, properties of matter, natural sources of power, and physical forces to satisfy human needs and desires. Typically, workers are engaged in conducting analyses and experiments of materials and systems by application of known laws and relationships; in conceiving and designing new structures, machines, tools, precision instruments, and other devices; in devising and constructing cooling, heating, lighting, communication, transportation, and other productive systems; in developing the most practical forms of new techniques, processes, and products; in performing structural, functional, and compositional tests of materials and parts; and in preparing technical reports of investigations.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply basic engineering principles and methods; good visual acuity with respect to graphic representations; creative talent or imagination; ability to perceive or visualize spatial relationships of plane and solid objects; logical mind; organizational ability; and facility in mathematics.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Level of attainment in language and mathematics as indicated by scores on aptitude tests and grades in educational courses.

Previous drawings or sketches produced, either freehand or mechanical.

Kind of literature read (whether scientifically or technically oriented).

Clear, coherent verbal expression.

Interest in scientific and technological developments.

TRAINING AND METHODS OF ENTRY: A bachelor's degree in engineering is usually the minimum educational requirement for entrance into this field. However, some draftsmen and engineering technicians having extensive experience together with some college-level training may qualify for entry.

Most employers require either advanced graduate degrees or significant experience on the basic engineering level for entry into research work.

Students interested in engineering should acquire a strong background in mathematics and the physical sciences.

RELATED CLASSIFICATIONS

Sales Engineering (.151)
Engineering, Scientific, and Technical Coordination
(.168)
Engineering and Related Work (.187)
Technical Work, Engineering and Related Fields
(.181; .281)
Industrial Engineering and Related Work (.188; .288)
Drafting and Related Work (.181; .281)

QUALIFICATIONS PROFILE*

GED: 6
SVP: 8 7
Apt: G V N S P Q K F M E C
1 1 1 1 2 4 3 3 3 5 4
2 2 2 3
Int: 7 8
Temp: 4 0 Y
Phys. Dem: S L 4 6

*For explanation, see page F-1



011.281 METALLURGIST, ASSISTANT (profess. & kin.)

JOB DEFINITION: Metallurgical-laboratory assistant; metallurgical tester; physical-laboratory assistant. Examines and tests metal samples to determine their physical properties, under direction of METALLURGIST, PHYSICAL. Conducts routine microscopic examinations of metals and alloys to determine their crystalline structure, porosity, homogeneity, and other characteristics. Prepares photographs of metal specimens, using photomicroscope, studies and interprets photographs, and compiles reports of findings. Examines metal and alloy samples with X-ray, gamma-ray, and magnetic-flux equipment to detect internal fractures, impurities, and similar defects in metals. Tests samples in pressure devices, hot-acid baths, and other apparatus to determine strength, hardness, elasticity, toughness, or other properties of metal.

AREA OF WORK: INVESTIGATING, INSPECTING AND TESTING

WORKER TRAITS GROUP: MATERIALS ANALYSIS AND RELATED WORK (.181; .281; .381).

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and related disciplines to the analysis, testing, and compounding of such materials as ores, foods, chemicals, and drugs. Activities range from primarily subjective evaluations, such as food-tasting, to objective evaluations of test data on the properties of such materials as fuels, gems, and textiles.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual ability and interest sufficient to acquire necessary academic background; attention to detail; a facility with mathematics; and form perception to recognize physical differences in materials.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed preference for research work.
- Academic success in science and laboratory courses in college or other scholastic environment.
- Active participation in extracurricular science activities.
- Experience assisting instructors in course work in sciences.

TRAINING AND METHODS OF ENTRY: Employers prefer to hire workers who have completed some courses in mathematics, engineering, chemistry, or physics, including related laboratory work. These workers are then given the opportunity to become proficient through on-the-job training. Some of these activities require the worker to have a bachelor's degree and be licensed by the State.

RELATED CLASSIFICATIONS

Appraising and Investigating Work (.187; .284; .287)
Inspecting and Stock Checking (.382; .384; .387;
.484; .487)
Sorting, Inspecting, Measuring, and Related Work
(.484; .485; .487; .584; .585; .683; .684;
.685; .687)
Mathematics, Physical Sciences, and Related
Research (.088; .188)
Scientific Research (.081)

QUALIFICATIONS PROFILE*

GED: 5 4
SVP: 7 6 5
Apt: G V N S P Q K F M E C
2 2 3 3 2 4 3 3 3 5 3
1 3 2 4 3 3 4 4 4 4
1 1 2 3
Int: 1 7 9
Temp: 0 Y
Phys. Dem: L 4 6

*For explanation, see page F-1

018.188 SURVEYOR, GEODETIC. (profess. & kin.).

JOB DEFINITION: Plans, directs, or conducts surveys of land areas of such size that shape and size of earth exerts sufficient influence on survey measurements to require use of special high-accuracy techniques including astronomical observations and complex computations to compile data used in preparation of geodetic maps and charts.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: SURVEYING, PROSPECTING, AND RELATED WORK (.188; .288)

WORK PERFORMED: Work activities in this group primarily involve determining and delineating the shape, size, location, and other aspects of natural and manmade objects or features on the earth's surface, and in exploring and examining underground earth formations. Typically, workers are engaged in taking linear and angular measurements of tracts of land; in obtaining and interpreting seismograms and other graphic indications or records of the composition and structure of underground formations; in locating positions of aircraft and directing their courses; in obtaining knowledge of particular terrains and presence or absence of manmade objects or features by studying aerial photographs; and in preparing maps, charts, sketches, and other graphic representations from the data collected.

WORKER REQUIREMENTS: An occupationally significant combination of: An understanding of the principles of geometry and trigonometry; a strong liking for outdoor work; ability to draw; finger dexterity; good vision and health; physical stamina, and the ability to perceive relationships of objects in space or to envision objects of two or three dimensions on flat surfaces.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Level of attainment in language and mathematics as indicated by scores on aptitude tests and grades in educational courses.

Drawings or sketches produced, either freehand or mechanical.

Participation in outdoor activities, such as scouting, hiking, or camping.

Hobbies, such as rock collecting.

Night school pre-engineering courses.

TRAINING AND METHODS OF ENTRY: A high school education is usually the minimum requirement for entry into the kinds of work described in this group. Adequate academic preparation should include courses in map reading, freehand and mechanical drawing, mathematics, geography, and the earth sciences.

Summer employment with surveying or prospecting teams in the construction or petroleum industries provides an excellent opportunity for students and others to obtain experience. Some employers offer formal courses in surveying with accompanying on-the-job training in survey techniques and in the use of surveying instruments.

Some technical or vocational schools, as well as some colleges, offer comprehensive programs in surveying. Extension courses are also available.

RELATED CLASSIFICATIONS:

Mathematics, Physical Sciences, and Related Research
(.088; .188)
Engineering and Related Work (.187)
Drafting and Related Work (.181; .281)
Materials Analysis and Related Work (.181; .281; .381)

QUALIFICATIONS PROFILE*

GED: 5 4
SVP: 7 6
Apt: G V N S P Q K F M E C
2 2 2 2 2 3 3 3 3 4 4
3
Int: 7 1 9
Temp: 0 Y
Phys. Dem: L M 2 4 6

*For explanation, see page F-1

022.081 CHEMIST, INORGANIC (profess. & kin.)

JOB DEFINITION: Conducts experiments on substances which are free or relatively free of carbon to develop and improve materials and products and to discover scientific facts: Prepares new inorganic compounds and investigates possibilities of application to medicine, industry, and other fields and areas. Develops new methods for preparing existing inorganic compounds. Records results of experiments and writes reports recommending application of further research. Engages in research to improve chemical methods for processing inorganic materials. May analyze metals, ores, gases, heavy chemicals, and other inorganic compounds to determine factors, such as composition, structure, chemical properties, and value, and to develop methods to improve these qualities. May specialize in particular element or class of compounds or specific industry or product.

SPECIALTY AREAS: CHEMIST, GLASS (glass mfg.) Glass Technologist. Conducts experiments in chemistry of glass, and develops and controls processes involved in manufacture of glass products: Devises and installs laboratory and batch-control systems. Selects formulas to be used in compounding standard types of glass, and develops new formulas to produce special-purpose glass, such as optical glass, glass ovenware, or colored glass products. Directs activities of operating crew engaged in compounding ingredients and charging melting furnaces. Ascertains furnace temperatures periodically with optical pyrometer, and makes necessary temperature adjustments. Determines characteristics of glass samples by subjecting them to chemical and physical tests.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed preference for research work.
- Academic success in scientific coursework in college.
- Active participation in extracurricular science activities.
- Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

RELATED CLASSIFICATIONS:

Materials Analysis and Related Work (.181; .281; .381)
 High School, College, University, Tutoring, and Related Education (.228)
 Health Physics (.021)
 Mathematics, Physical Sciences, and Related Research (.088; .188)
 Technical Work, Science and Related Fields (.384)
 Engineering, Scientific, and Technical Coordination (.168)

QUALIFICATIONS PROFILE*

GED: 5 6
 SVP: 7 8
 Apt: G V N S P Q K F M E C
 1 1 1 1 1 1 2 2 2 3 2
 2 2 2 2 2 2 3 3 3 4 3
 3 5
 Int: 1 7 8
 Temp: 1 9 0 Y
 Phys. Dem: S L 2 3 4 5 6

*For explanation, see page F-1

022.081 CHEMIST, PHYSICAL (profess. & kin.)

JOB DEFINITION: Conducts research into relationships between chemical and physical properties of organic and inorganic substances and compounds: Determines atomic and molecular weights of substances, including crystal forms, using X-ray diffraction, thermomagnetic analysis, microporosity measurement, and other techniques. Measures heat of substances under varying conditions to determine boiling and freezing points and to ascertain physical and chemical characteristics under those conditions. Induces changes in composition of substances by introduction of thermal, light, and electrical energy and chemical catalysts. Studies rate of chemical reaction and determines catalytic action required to increase reaction rate. Examines molecules to ascertain structure, electrical energy, and reaction to energy changes, using electron microscope and other instruments. Develops techniques for use of instruments that measure heat, light, and electricity.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed preference for research work.
- Academic success in scientific coursework in college.
- Active participation in extracurricular science activities.
- Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

RELATED CLASSIFICATIONS:

Materials Analysis and Related Work (.181; .281; .381)
 High School, College, University, Tutoring, and Related Education (.228)
 Health Physics (.021)
 Mathematics, Physical Sciences, and Related Research (.088; .188)
 Technical Work, Science and Related Fields (.384)
 Engineering, Scientific, and Technical Coordination (.168)

QUALIFICATIONS PROFILE*

GED:	5	6									
SVP:	7	8									
Apt:	G	V	N	S	P	Q	K	F	M	E	C
	1	1	1	1	1	1	2	2	2	3	2
	2	2	2	2	2	2	3	3	3	4	3
						3					5
Int:	1	7	8								
Temp:	1	9	0	Y							
Phys. Dem:	S	L	2	3	4	5	6				

*For explanation, see page F-1

023.081 PHYSICIST (profess. & kin.)

JOB DEFINITION: Conducts research into phases of physical phenomena, develops theories and laws on basis of observation and experiments, and devises methods to apply laws and theories of physics to industry, medicine, and other fields: Performs experiments with masers, lasers, cyclotrons, betatrons, telescopes, mass spectrometers, electron microscopes, and other equipment to observe structure and properties of matter, transformation and propagation of energy, relationships between matter and energy, and other physical phenomena. Describes and expresses observations and conclusions in mathematical terms. Devises procedures for physical testing of materials. Conducts instrumental analyses to determine physical properties of materials. May apply methodology of physics to a particular physical property or phenomenon. May engage in teaching.

SPECIALTY AREAS: PHYSICIST, HEAT (profess. & kin.) Physicist, Thermodynamics. Conducts research into nature and properties of heat and its conversion into energy: Performs experiments involving measurement, development, transmission, and effects of heat. Studies effects of low and high temperatures on physical properties of matter. Devises methods to solve such problems as reducing heat loss in fuel consumption and in operation of jet engines. Develops techniques and instruments for observation of materials at high or low temperatures. Examines relationship between amount of heat expended and energy involved.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed preference for research work.
- Academic success in scientific coursework in college.
- Active participation in extracurricular science activities.
- Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

RELATED CLASSIFICATIONS:

Materials Analysis and Related Work (.181; .281; .381)
 High School, College, University, Tutoring, and Related Education (.228)
 Health Physics (.021)
 Mathematics, Physical Sciences, and Related Research (.088; .188)
 Technical Work, Science and Related Fields (.384)
 Engineering, Scientific, and Technical Coordination (.168)

QUALIFICATIONS PROFILE*

GED: 5 6
 SVP: 7 8
 Apt: G V N S P Q K F M E C
 1 1 1 1 1 1 2 2 2 3 2
 2 2 2 2 2 2 3 3 3 4 3
 3 5
 Int: 1 7 8
 Temp: 1 9 0 Y
 Phys. Dem: S L 2 3 4 5 6

*For explanation, see page F-1

024.081 GEOLOGIST (profess. & kin.)

JOB DEFINITION: Studies composition, structure, and history of earth's crust: Examines rocks, minerals, and fossil remains to identify and determine sequence of processes affecting development of earth. Applies knowledge of chemistry, physics, biology, and mathematics to explain these phenomena and to help locate mineral and petroleum deposits and underground water resources. Studies ocean bottom. Applies geological knowledge to engineering problems encountered in construction projects, such as dams, tunnels, and large buildings. Studies fossil plants and animals to determine their evolutionary sequence and age. Prepares geologic reports and maps, interprets research data, and recommends further study or action. May specialize in area of study and be designated GEOLOGIST, ENGINEERING; GEOLOGIST, GROUND WATER; GEOLOGIST, MINING.

SPECIALTY AREAS: GEOLOGIST, PETROLEUM (petrol. production). Explores and charts stratigraphic arrangement and composition of earth to locate gas and oil deposits: Studies well logs, analyzes cores and cuttings from well drillings, and interprets data obtained by electrical or radioactive well logging and other subsurface surveys to identify earth strata. Examines aerial photographs, evaluates results of geophysical prospecting, and prepares surface and subsurface maps and diagrams depicting stratigraphic arrangement and composition of earth and probable deposits of gas and oil. Recommends acquisition, retention, or release of property leases or contracts. Estimates oil reserves in proven or prospective fields, and consults with PETROLEUM ENGINEERS concerning drilling and production methods. May direct drilling of shallow exploratory wells. GEOMORPHOLOGIST (profess. & kin.). Studies form of earth's surface and forces, such as erosion, glaciation, and sedimentation, causing changes in land formation.

MINERALOGIST (profess. & kin.). Examines, analyzes and classifies minerals, gems, and precious stones: Isolates specimen from ore, rocks, or matrices. Makes microscopic examination to determine shape, surface markings, and other physical characteristics. Performs physical and chemical tests and makes X-ray examinations to determine composition of specimen and type of crystalline structure. Identifies and classifies samples. Develops data and theories on mode of origin, occurrence, and possible uses of minerals. OCEANOGRAPHER, GEOLOGICAL (profess. & kin.). Geologist, Marine. Studies topographic features, rocks and sediments of ocean bottom.

PALEONTOLOGIST (profess. & kin.). Studies fossilized remains of plants and animals found in geological formations to trace evolution and development of past life and identify geological formations according to nature and chronology: Recovers and assembles fossilized specimens, notes their positions, and classifies them according to their botanical or zoological family and probable age. Prepares treatises on findings for furtherance of scientific study or as an aid to location of natural resources, such as petroleum-bearing formations. May organize scientific expeditions and supervise removal of fossils from deposits and matrix rock formations. May specialize in study of plant fossils and be designated PALEOBOTANIST. May specialize in study of fossilized micro-organisms and be designated MICROPALAEONTOLOGIST.

PETROLOGIST (profess. & kin.). Investigates composition, structure, and history of rock masses forming earth's crust: Applies findings to such fields of investigation as causes of formations, breaking down and weathering, chemical composition and forms of deposition of sedimentary rocks, methods of eruption, and origin and causes of metamorphosis.

PHOTOGEOLOGIST (profess. & kin.). Examines and interprets aerial photographs with aid of three-dimensional viewing device to identify rock types, structural trends, seam and fault alignments indicating subsurface geology, and other topographical features of value in geological surveying or mineral exploration.

STRATIGRAPHER (profess. & kin.). Studies relative position and order of succession of deposits containing or separating archaeological material. Studies relation of life of past ages, evolutionary changes as recorded by fossil animals and plants, and successive changes in distribution of land and sea as interpreted from character of fossil content of sedimentary rocks.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed preference for research work.
- Academic success in scientific coursework in college.
- Active participation in extracurricular science activities.
- Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

024.081 GEOLOGIST (profess. & kin.). (Continued)

AREA OF WORK: MATHEMATICS AND SCIENCE (Continued)

RELATED CLASSIFICATIONS

Materials Analysis and Related Work (.181; .281; .381)
 High School, College, University, Tutoring, and
 Related Education (.228)
 Health Physics (.021)
 Mathematics, Physical Sciences, and Related Research
 (.088; .188)
 Technical Work, Science and Related Fields (.384)
 Engineering, Scientific, and Technical Coordination
 (.168)

QUALIFICATIONS PROFILE*

GED: 5 6
 SVP: 7 8
 Apt: G V N S P Q K F M E C
 1 1 1 1 1 1 2 2 2 3 2
 2 2 2 2 2 2 3 3 3 4 3
 3 5
 Int: 1 7 8
 Temp: 1 9 0 Y
 Phys. Dem: S L 2 3 4 5 6

*For explanation, see page F-1

024.081 GEOPHYSICIST (profess. & kin.)

JOB DEFINITION: Studies physical aspects of earth, including its atmosphere and hydrosphere: Investigates and measures seismic, gravitational, electrical, thermal, and magnetic forces affecting earth, utilizing principles of physics, mathematics, and chemistry. Analyzes data obtained to compute shape of earth, estimate composition and structure of earth's interior, determine flow pattern of ocean tides and currents, study physical properties of atmosphere, and help to locate petroleum and mineral deposits. Investigates origin and activity of glaciers, volcanoes, and earthquakes. Compiles data to prepare navigational charts and maps, predict atmospheric conditions, and establish water supply and flood-control programs.

SPECIALTY AREAS: **GEODESIST** (profess. & kin.). Employs surveying and geodetic instruments, such as transits, theodolites, and other engineering instruments, in setting up and improving network of triangulation over earth's surface in order to provide fixed points for use in making maps. Establishes bench marks (known points of elevation). Performs gravimetric surveying to determine variations in earth's gravitational field, and provides data used in determination of weight, size, and mass of earth.

GEOMAGNETICIAN (profess. & kin.). Terrestrial Magnetician. Sets up magnetic observatories and stations to chart earth's magnetic field. Applies data obtained to problems in fields of telephony, telegraphy, radio broadcasting, navigation, mapping, and geophysical prospecting.

GEOPHYSICAL PROSPECTOR (petrol. production). Studies structure of subsurface rock formations to locate petroleum deposits, using such physical and electrical testing instruments as seismograph, gravimeter, torsion balance, magnetometer, pendulum devices, and electrical-resistivity apparatus to measure various characteristics of earth. Computes, from instrument readings, variations in physical forces existing at different locations, and interprets data to reveal subsurface structures likely to contain petroleum deposits. Prepares charts, profiles, or subsurface contour maps. Determines desirable locations for drilling operation. Oversees field crews drilling shallow boreholes in designated terrain and collecting samples of soil for chemical analysis of hydrocarbon content. May be designated according to type of equipment used as **ELECTRICAL PROSPECTOR**; **GRAVITY PROSPECTOR**; **MAGNETIC PROSPECTOR**; **SEISMIC PROSPECTOR**.

GLACIOLOGIST (profess. & kin.). Studies effects of glaciation in changing surface of earth.

HYDROLOGIST (profess. & kin.). Studies distribution, disposition, and development of waters of land areas, including form and intensity of precipitation, and modes of return to ocean and atmosphere. Maps and charts water flow and disposition of sediment. Measures changes in water volume due to evaporation and melting of snow. Studies storm occurrences and nature and movement of glaciers, and determines rate of ground absorption and ultimate disposition of water. Evaluates data obtained in reference to such problems as flood and drought forecasting, soil and water conservation programs, and planning water supply, water power, flood control, drainage, irrigation, crop production, and inland navigation projects.

OCEANOGRAPHER, PHYSICAL (profess. & kin.). Studies physical aspects of ocean, such as density, temperature, and ability to transmit light and sound; movement of sea, such as waves, tides, and currents; and relationship between sea and atmosphere.

SEISMOLOGIST (profess. & kin.). Works at fixed locations throughout globe and studies courses and phenomena of earthquakes, using special devices and machines, including seismograph. Establishes existence of active fault lines or areas where earthquakes have occurred and near which it would be hazardous to build cities, dams, or lofty structures.

TECTONOPHYSICIST (profess. & kin.). Studies elastic deformation of flow and rupture of constituent materials of earth's crust and makes deductions concerning forces causing these deformations (changes). Studies formation of strata underlying continents and ocean beds, and forces at work in earth's crust, and general structure of coastal layers. Work is mostly research and findings applicable to prospecting.

VOLCANOLOGIST (profess. & kin.). Studies occurrence, origin, and activity of volcanoes; origin of igneous rocks; and ore-forming processes occurring in earth in presence of igneous rock. Performs duties as described under **GEOPHYSICAL PROSPECTOR** (petrol. production) in studying ore bodies that may be commercially exploitable.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORK REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed preference for research work.
- Academic success in scientific coursework in college.
- Active participation in extracurricular science activities.
- Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.



024.081 GEOPHYSICIST (profess. & kin.) (Continued)

AREA OF WORK: MATHEMATICS AND SCIENCE (Continued)

RELATED CLASSIFICATIONS:

Materials Analysis and Related Work (.181; .281;
.381)
High School, College, University, Tutoring, and
Related Education (.228)
Health Physics (.021)
Mathematics, Physical Sciences, and Related Research
(.088; .188)
Technical Work, Science and Related Fields (.384)
Engineering, Scientific, and Technical Coordination
(.168)

QUALIFICATIONS PROFILE*

GED: 5 6
SVP: 7 8
Apt: G V N S P Q K F M E C
1 1 1 1 1 1 2 2 2 3 2
2 2 2 2 2 2 3 3 3 4 3
3 5
Int: 1 7 8
Temp: 1 9 0 Y
Phys. Dem: S L 2 3 4 5 6

*For explanation, see page F-1

025.088 METEOROLOGIST (profess. & kin.).

JOB DEFINITION: Synoptic meteorologist; weather forecaster; weather man. Studies and interprets atmospheric conditions and related meteorological data to forecast immediate and long range changes in weather: Analyzes and interprets synoptic charts, maps, prognostic charts, and meteorological data, such as barometric pressure, temperature, humidity, wind velocity, and areas of precipitation, to make forecast. Investigates meteorological aspects of radio propagation, aurora and air glow, and cosmic rays. Conducts research into long range forecasting [CLIMATOLOGIST], severe weather phenomena, solar heating, and other problems. Draws isobars on surface maps, indicating fronts, areas of precipitation, high and low barometric pressure, and falling and rising pressure, and predicts movements of fronts, precipitation, and pressure areas. Advises AIRPLANE PILOT, COMMERCIAL (air trans.) and other flight personnel regarding meteorological data, such as winds aloft, ceilings, visibility, icing conditions, thunderstorms, and other forms of turbulence, and movements of cloud formations.

SPECIALTY AREAS: CLIMATOLOGIST (profess. & kin.). Interprets statistical data on wind, rainfall, sunshine, temperature, and other aspects of climate of particular area over extended period of time to predict future climatic conditions. Develops and utilizes statistical and other methods to analyze and interpret climatological data.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: MATHEMATICS, PHYSICAL SCIENCES, AND RELATED RESEARCH (.088; .188)

WORK PERFORMED: Work activities in this group primarily involve investigation into atmospheric, astronomical, and geographical phenomena and conditions, into theoretical aspects of physics and mathematics, and into automatic data-processing systems and programs. Typically, workers are engaged in collecting and analyzing data on the nature, composition, structure, and other features of the earth, atmosphere, and celestial bodies; in formulating theories on time, space, weather, matter and energy, motion of heavenly bodies, and other aspects of the physical world; in analyzing data-processing problems, stating problems in computer language, and determining computational methods and sequence of machine operations for solution of problems; in developing new mathematical and statistical methods, formulas, and relationships; and in communicating research findings through reports, lectures, technical publications, and other media.

WORKER REQUIREMENTS: An occupationally significant combination of: Ability to understand the basic laws of nature and scientific methods of investigation; inventiveness; ability to represent and relate abstract ideas by means of symbols; organizational ability; retentive memory; clerical perception; lucid verbal expression; ability to perceive or envision relative paths or positions of stationary and moving objects; and the ability to grasp mathematical and statistical concepts.

CLUES FOR RELATING APPLICANT AND REQUIREMENTS:

Level of attainment in language and mathematics as indicated by scores on aptitude tests and grades in school.

Interest in figures or numbers.

Interest in scientific and technological developments.

Kind of literature read (whether scientifically oriented or not).

TRAINING AND METHODS OF ENTRY: A bachelor's degree in the appropriate subject matter, such as mathematics, astronomy, and geography, is a minimum educational requirement for entrance into this type of work. For the more responsible research positions an advanced degree is necessary. A Ph.D. is usually essential for entrance into astronomy. Workers in pure mathematics seldom require training in a particular field, but those in applied mathematics must acquire knowledge of the field in which mathematics is used.

RELATED CLASSIFICATIONS:

Scientific Research (.081)
High School, College, University, Tutoring, and
Related Education (.228)
Engineering, Scientific, and Technical Coordination
(.168)
Materials Analysis and Related Work (.181; .281; .381)
Technical Work, Science and Related Fields (.384)

QUALIFICATIONS PROFILE*

GED: 6 5
SVP: 8 7
Apt: G V N S P Q K F M E C
1 1 1 1 3 2 4 4 4 5 5
2 2 2 2 2 3
Int: 7 8
Temp: 4 0 9
Phys. Dem: S 4 6

*For explanation, see page F-1

025.288 WEATHER OBSERVER (profess. & kin.).

JOB DEFINITION: Meteorological aid. Observes and records weather conditions for use in forecasting: Periodically observes general weather, sky and visibility conditions, and reads weather instruments including thermometers, barometers, and hydrometers to ascertain elements, such as temperature, barometric pressure, wind velocity, visibility, and precipitation. Calculates winds aloft by following balloon's ascent with theodolite, recording angles of azimuth and elevation at specific time intervals, and converting readings into wind speed and direction, using charts and mathematical tables. Decodes weather data received by teletypewriter and plots synoptic charts of large geographical areas, such as North America.

SPECIALTY AREAS: WEATHER-CHART PREPARER (profess. & kin.) Meteorological plotter; weather-chart plotter. Plots weather maps and charts from weather reports on basis of which weather forecasts are made: Employs code books and knowledge of code to decode weather observations received by teletypewriter from observation stations covering large geographical areas such as North America. Records weather data on synoptic maps using standard meteorological symbols to construct large numbers of station models showing elements, such as barometric pressure, temperature, cloud cover, precipitation, and visibility. Decodes data and plots upper-air charts, winds-aloft maps, and radiosonde soundings.

AREA OF WORK: ENGINEERING

WORKER TRAITS GROUP: SURVEYING, PROSPECTING, AND RELATED WORK (.188; .288)

WORK PERFORMED: Work activities in this group primarily involve determining and delineating the shape, size, location, and other aspects of natural and manmade objects or features on the earth's surface, and in exploring and examining underground earth formations. Typically, workers are engaged in taking linear and angular measurements of tracts of land; in obtaining and interpreting seismograms and other graphic indications or records of the composition and structure of underground formations; in locating positions of aircraft and directing their courses; in obtaining knowledge of particular terrains and presence or absence of manmade objects or features by studying aerial photographs; and in preparing maps, charts, sketches, and other graphic representations from the data collected.

WORKER REQUIREMENTS: An occupationally significant combination of: An understanding of the principles of geometry and trigonometry; strong liking for outdoor work; ability to draw; finger dexterity; good vision and health; physical stamina, and the ability to perceive relationships of objects in space or to envision objects of two or three dimensions on flat surfaces.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Level in attainment in language and mathematics as indicated by scores on aptitude tests and grades in educational courses.
- Drawings or sketches produced, either freehand or mechanical.
- Participation in outdoor activities, such as scouting, hiking, or camping.
- Hobbies, such as rock collecting.
- Night school pre-engineering courses.

TRAINING AND METHODS OF ENTRY: A high school education is usually the minimum requirement for entry into the kinds of work described in this group. Adequate academic preparation should include courses in map reading, freehand and mechanical drawing, mathematics, geography, and the earth sciences.

Summer employment with surveying or prospecting teams in the construction or petroleum industries provides an excellent opportunity for students and others to obtain experience. Some employers offer formal courses in surveying with accompanying on-the-job training in survey techniques and in the use of surveying instruments.

Some technical or vocational schools, as well as some colleges, offer comprehensive programs in surveying. Extension courses are also available.

RELATED CLASSIFICATIONS:

Mathematics, Physical Sciences, and Related Research
(.088; .188)
Engineering and Related Work (.187)
Drafting and Related Work (.181; .281)
Materials Analysis and Related Work (.181; .281; .381)

QUALIFICATIONS PROFILE*

GED: 5 4
SVP: 7 6
Apt: G V N S P Q K F M E C
2 2 2 2 2 3 3 3 3 4 4
3
Int: 7 1 9
Templ 0 Y
Phys. Dem: L M 2 4 6

*For explanation, see page F-1

041.081 BIOCHEMIST

JOB DEFINITION: Chemist, biological. Studies chemical processes of living organisms: Conducts research to determine action of foods, drugs, serums, hormones, and other substances on tissues and vital processes of living organisms. Isolates, analyzes, and identifies hormones, vitamins, allergens, minerals, and enzymes and determines effects on body functions. Examines chemical aspects of formation of antibodies, and conducts research into chemistry of cells and blood corpuscles. Studies chemistry of body processes such as breathing and digestion, and of living energy changes such as growth, aging, and death. May specialize in particular area or field of work, and be designated CHEMIST, CLINICAL; CHEMIST, ENZYMES; CHEMIST, PROTEINS; CHEMIST, STEROIDS. May clean, purify, refine, and otherwise prepare pharmaceutical compounds for commercial distribution, develop new drugs and medications, and be designated CHEMIST, PHARMACEUTICAL.

AREA OF WORK: MATHEMATICS AND SCIENCE

WORKER TRAITS GROUP: SCIENTIFIC RESEARCH (.081)

WORK PERFORMED: Work activities in this group primarily involve applying principles of chemistry, physics, metallurgy, and astronomy to (1) basic research designed to increase man's knowledge of the properties of matter and energy, (2) applied research designed to utilize the knowledge gained from basic research in order to develop new products and processes, and (3) the solution of practical scientific problems.

WORKER REQUIREMENTS: An occupationally significant combination of: Intellectual capacity and interest sufficient to acquire necessary academic background and to absorb and interpret scientific theories and data; thoroughness and penchant for detail; a facility with mathematics; and an inquisitive mind and fertile imagination.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Expressed preference for research work.
- Academic success in scientific coursework in college.
- Active participation in extracurricular science activities.
- Experience assisting instructors in coursework.

TRAINING AND METHODS OF ENTRY: A bachelor's degree with a major in the specialty area is the minimum requirement for entrance into the field, with graduate degrees needed for more responsible research work and teaching. A master's degree usually qualifies an individual for a position in applied research and for a laboratory teaching position in a college, university, or industrial research setting. A Ph.D. is generally required for a position in basic research and more advanced entry positions.

RELATED CLASSIFICATIONS:

Materials Analysis and Related Work (.181; .281; .381)
 High School, College, University, Tutoring, and Related Education (.228)
 Health Physics (.021)
 Mathematics, Physical Sciences, and Related Research (.088; .188)
 Technical Work, Science and Related Fields (.384)
 Engineering, Scientific, and Technical Coordination (.168)

QUALIFICATIONS PROFILE*

GED: 5 6
 SVP: 7 8
 Apt: G V N S P Q K F M E C
 1 1 1 1 1 1 2 2 2 3 2
 2 2 2 2 2 2 3 3 3 4 3
 3 5
 Int: 1 7 8
 Temp: 1 9 0 Y
 Phys. Dem: S L 2 3 4 5 6

*For explanation, see page F-1



710.884 CALIBRATOR (inst. & app.)

JOB DEFINITION: I. Performs any combination of tasks involved in calibrating control instruments, such as thermostats, timing, and pressure-regulating devices: Selects and installs adapter and indicating gages on test fixture according to written specifications. Sets controls to regulate current flow, timing cycle, pressure, or temperature to specifications for device being tested. Positions dial plate of controls at reference point and adjusts calibration screw so that contact points open and close at specified temperature or pressure. Bends contact blades of device to adjust blades for length of travel time, using feeler gages and hand tools. Positions potentiometer blades to obtain specified galvanometer reading, using screwdriver and feeler gage. Places sealing compound on adjustment screws to prevent readjustment of breaker points. II. Tests calibration of barometer assemblies, using vacuum chamber: Positions assemblies on racks in vacuum chamber. Connects each assembly to lead of radio transmitter. Records serial number of each barometer assembly on paper tape where signal will appear. Starts vacuum pump to decrease atmospheric pressure in chamber. Stops pump and turns valve to admit air to chamber and increase pressure. Barometer assembly activates transmitter that gives off signals indicating functional characteristics of assembly. Signals are recorded on paper tape. Removes paper tape and reads recorded signals. Removes defective assemblies from chamber and routes them for repairs or adjustments.

AREA OF WORK: CRAFTS

WORKER TRAITS GROUP: MANIPULATING (.884)

WORK PERFORMED: Work activities in this group primarily involve the dexterous use of hands, hand tools, or special devices to work, move, guide, or place objects or materials. There exists some latitude for judgment in selecting the appropriate tools, objects, or materials, and in determining work procedures and conformance to standards, although all these factors are fairly obvious. The work most frequently occurs away from a machine-oriented environment, and is prevalent in such endeavors as bench crafts, structural work, and hunting and fishing.

WORKER REQUIREMENTS: An occupationally significant combination of: Eye-hand coordination; manual and finger dexterity; spatial and form perception; a decided preference for working with the hands; the ability to work within prescribed standards and specifications; and facility in adapting to a routine.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Success in craft courses in school.
- Hobby of making scale-model boats and airplanes.
- Expressed preference for working with the hands.
- Hobbies of hunting and fishing.

TRAINING AND METHODS OF ENTRY: Apprenticeship programs and on-the-job training are the usual means by which a worker becomes familiar with his job. On occasions, experience in a lesser capacity can prepare an applicant for entry into this type of work, provided he has shown diligence and the capacity for more involved tasks. Individuals with some exposure to disciplined and standardized work methods in a school or related environment will usually be given preference.

RELATED CLASSIFICATIONS

Craftsmanship and Related Work (.281; .381)
Tending (.885)
Feeding-Offbearing (.886)
Handling (.887)

QUALIFICATIONS PROFILE*

GED: 2 3
SVP: 3 4 5 2 6
Apt: G V N S P Q K F M E C
3 4 4 4 3 5 3 3 3 5 5
4 5 3 4 4 4 4 4 4 4
Int: 9 3 1 0
Temp: 2 Y
Phys. Dem: S L M H 2 3 4 6

*For explanation, see page F-1

714.684 CAMERA INSPECTOR (photo. apparatus)

JOB DEFINITION: Photographic-equipment inspector. Inspects still or motion picture cameras, magazines, enlargers, flash units, film developing machines, and other photographic equipment: Examines equipment for defects, such as missing parts, incorrect serial numbers, flaws in castings, and light leakage, and verifies timing and focus. Trips shutter to verify timing, using timing device. Measures focal distance of lenses, using depth micrometer. Tests electrical components, using electrical instruments. May be designated according to item inspected, as CAMERA-CASING INSPECTOR; FILM-ROLLER INSPECTOR; MOTION-PICTURE-CAMERA INSPECTOR.

AREA OF WORK: INVESTIGATING, INSPECTING, AND TESTING

WORKER TRAITS GROUP: SORTING, INSPECTING, MEASURING, AND RELATED WORK (.484; .485; .487; .584; .585; .587; .683; .684; .685; .687).

WORK PERFORMED: Work activities in this group primarily involve examining, measuring, or weighing objects or materials for the purpose of grading, sorting, detecting flaws or irregularities, or verifying adherence to specifications. The work frequently is performed under close supervision, and the use of gages, calipers, micrometers, and other measuring devices or equipment, as well as the primary senses, is often involved.

WORKER REQUIREMENTS: An occupationally significant combination of: The ability and willingness to follow instructions to the letter; spatial and form perception to perceive differences in tangible matter; accuracy and attention to detail; finger and manual dexterity; eye-hand coordination; and disposition toward work of a routine, repetitive, and noncreative nature.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

School shop courses indicating success in working to tolerances.

Willingness to fit into a routine.

Casual work experience sorting stock at inventory time in local plant.

TRAINING AND METHODS OF ENTRY: Workers generally learn the fundamentals of their jobs during a brief period of on-the-job training, which may range from a few hours to several months, depending on the skill required. Many employers prefer workers with no previous experience. They look for applicants who are physically able, dependable, have good eyesight, and can follow instructions. Many of the larger employers give aptitude tests in selecting new employees.

RELATED CLASSIFICATIONS

Inspecting and Stock Checking (.382; .384; .387; .484; .487)
Routine Checking and Recording (.588; .688)
Tending (.884)

QUALIFICATIONS PROFILE*

GED: 2 3 1
SVP: 2 3 4
Apt: G V H S P Q K F H E C
4 4 4 4 4 4 4 4 3 5 4
3 5 3 3 3 3 3 4 5
3
Int: 1 3 9
Temp: 2 Y 0 3
Phys. Dem: S L M 4 5 6

*For explanation, see page F-1

722.281 INSPECTOR, SYSTEMS (Electronics)

JOB DEFINITION: Inspector, electronic assembly; quality-control inspector, electronic assembly. Inspects electronic systems, such as radar navigation, telemetering equipment, and computer memory units, following blueprints, wiring diagrams, customer or contract specifications, and manufacturing standards, and using precision measuring instruments. Compares layout and installation of wiring, cables, subassemblies, hardware, and components with specifications to detect assembly errors. Examines joints, using magnifying glass and mirrors, and pulls wires and cables to locate soldering defects. Twists parts, such as dials, shafts, and gears, to verify operation of parts. Measures parts for conformance with specified dimensions, using precision measuring instruments, such as micrometers and vernier gages. Records inspection data, such as serial numbers of inspected equipment, type and amount of defects, and rework required for defective equipment. Stamps inspected equipment to indicate acceptance. May resolder broken connections. May perform functional tests, using electronic test equipment, such as frequency meters, oscilloscopes, and power measuring instruments [TESTER, SYSTEMS].

AREA OF WORK: CRAFTS

WORKER TRAITS GROUP: CRAFTSMANSHIP AND RELATED WORK (.281; .381).

WORK PERFORMED: Work activities in this group primarily involve fabricating, processing, inspecting, or repairing material, products, or structural units. Activities in this group are characterized by the emphasis placed upon manual skills, and the application of an organized body of knowledge related to materials, tools, and principles associated with various crafts.

WORK REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply craft techniques, processes, and principles; ability to use independent judgment in planning sequence of operations and in selecting proper tools and materials; ability to assume responsibility for attainment of prescribed qualitative standards; ability to apply shop mathematics to practical problems, such as computing dimensions and locating reference points from specifications data when laying out work; spatial perception to visualize arrangement and relationships of static or moving parts and assemblies represented in blueprints and diagrams; form perception as required in such activities as inspecting finished work to verify acceptability of surface finish; and some combination of finger and manual dexterity and eye-hand coordination to use handtools and manually controlled power tools when executing work to close tolerances.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

Hobbies, such as model building or ceramics, which involve hand craftsmanship.

Successful completion of high school industrial arts or vocational education courses.

Military training and experience in craft-related activities.

Preference for work activities offering tangible productive satisfaction.

TRAINING AND METHODS OF ENTRY: Apprenticeships providing 2 to 6 years of on-the-job training and trade instruction are generally accepted as the best methods of entry into craft work. Many firms have established on-the-job training programs in which entry workers are placed under the supervision of a journeyman or a foreman and are advanced from elementary tasks to progressively more difficult work as they demonstrate increased proficiency in the skills of the craft. Training received in vocational, trade, or technical schools or the armed services enhance entry and advancement prospects, and may shorten training periods in some crafts. Craftsmen who become thoroughly familiar with all aspects of their trade through apprenticeship training generally stand the best chance for advancement to supervisory positions.

RELATED CLASSIFICATIONS

Drafting and Related Work (.181; .281)
Manipulating (.884)
Cooking and Related Work (.281; .381)
Precision Working (.781)

QUALIFICATIONS PROFILE*

GED: 4 3
SVP: 7 6 8
Apt: G V N S P Q K F M E C
3 3 3 2 3 4 3 3 3 5 5
2 4 4 3 4 2 2 2 2 4
2 2 3 3
Int: 1 9 0
Temp: 0 Y
Phys. Dem: L M H 2 3 4 6

*For explanation, see page F-1

828.281 ELECTRONICS MECHANIC (any ind.)

JOB DEFINITION: Communication technician; electronics-equipment mechanic; electronics-maintenance man; electronics specialist; electronics-system mechanic; electronics technician. Repairs electronic equipment, such as computers, industrial controls, radar systems, telemetering and missile control systems, transmitters, antennas, and servomechanisms, following blueprints and manufacturers' specifications, and using handtools and test instruments. Tests faulty equipment and applies knowledge of functional operation of electronic units and systems to diagnose cause of malfunction. Tests electronic components and circuits to locate defects, using instruments, such as oscilloscopes, signal generators, ammeters, and voltmeters. Replaces defective components and wiring and adjusts mechanical parts, using handtools and soldering iron. Aligns, adjusts, and calibrates equipment according to specifications. Calibrates testing instruments. Maintains records of repairs, calibrations, and tests. May install equipment in industrial or military establishments and in aircraft and missiles. May operate equipment, such as communication equipment and missile control systems in ground and flight tests, and may be required to hold license from governmental agency. May be designated according to type of equipment repaired as ELECTRONICS MECHANIC, COMPUTER; RADAR MECHANIC.

SPECIALTY AREAS: COMPONENT-INSPECTION TECHNICIAN (electronics). Inspects and repairs electronic computer components and subassemblies, following schematic diagrams and specifications and using handtools and electronic testing instruments. Records inspection results and replacements made. CUSTOMER-ENGINEERING SPECIALIST (office mach.) field-service technician, computers. Installs and repairs electronic computers and auxiliary equipment in company plant and at customers' establishments in accordance with written diagnostic and maintenance procedures and diagrams, using handtools and electronic testing instruments, such as oscilloscope and multimeters. Keeps performance records of computers serviced. Advises customers concerning operation, maintenance, and programming of computers.

AREA OF WORK: CRAFTS

WORKER TRAITS GROUP: CRAFTSMANSHIP AND RELATED WORK (.281; .381).

WORK PERFORMED: Work activities in this group primarily involve fabricating, processing, inspecting, or repairing materials, products, or structural units. Activities in this group are characterized by the emphasis placed upon manual skills, and the application of an organized body of knowledge related to materials, tools, and principles associated with various crafts.

WORK REQUIREMENTS: An occupationally significant combination of: Ability to learn and apply craft techniques, processes, and principles; ability to use independent judgment in planning sequence of operations and in selecting proper tools and materials; ability to assume responsibility for attainment of prescribed qualitative standards; ability to apply shop mathematics to practical problems, such as computing dimensions and locating reference points from specifications data when laying out work; spatial perception to visualize arrangement and relationships of static or moving parts and assemblies represented in blueprints and diagrams; form perception as required in such activities as inspecting finished work to verify acceptability of surface finish; and some combination of finger and manual dexterity and eye-hand coordination to use handtools and manually controlled power tools when executing work to close tolerances.

CLUES FOR RELATING APPLICANTS AND REQUIREMENTS:

- Hobbies, such as model building or ceramics, which involve hand craftsmanship.
- Successful completion of high school industrial arts or vocational education courses.
- Military training and experience in craft-related activities.
- Preference for work activities offering tangible productive satisfaction.

TRAINING METHODS OF ENTRY: Apprenticeships providing 2 to 6 years of on-the-job training and trade instruction are generally accepted as the best methods of entry into craft work. Many firms have established on-the-job training programs in which entry workers are placed under the supervision of a journeyman or a foreman and are advanced from elementary tasks to progressively more difficult work as they demonstrate increased proficiency in the skills of the craft. Training received in vocational, trade, or technical schools or the armed services enhance entry and advancement prospects, and may shorten training periods in some crafts. Craftsmen who become thoroughly familiar with all aspects of their trade through apprenticeship training generally stand the best chance for advancement to supervisory positions.

RELATED CLASSIFICATIONS

Drafting and Related Work (.181; .281)
Manipulating (.884)
Cooking and Related Work (.281; .381)
Precision Working (.781)

QUALIFICATIONS PROFILE*

GED:	4	3						
SVP:	7	6	8					
Apt:	G	V	N	S	P	Q	K	F
	3	3	3	2	3	4	3	3
	2	4	4	3	4	2	2	2
				2		3		
								2
Int:	1	9	0					
Temp:	0	Y						
Phys. Dem:	L	M	H	2	3	4	6	

*For explanation, see page F-1

**DEVELOPMENT OF FLIGHT EXPERIMENT
WORK PERFORMANCE AND
WORKSTATION INTERFACE REQUIREMENTS**

CONTRACT NAS8-28359

FINAL REPORT

**APPENDIX G
WORKSTATION CONCEPTS SUPPORTING DATA**

APPENDIX G

WORKSTATION CONCEPTS SUPPORTING DATA

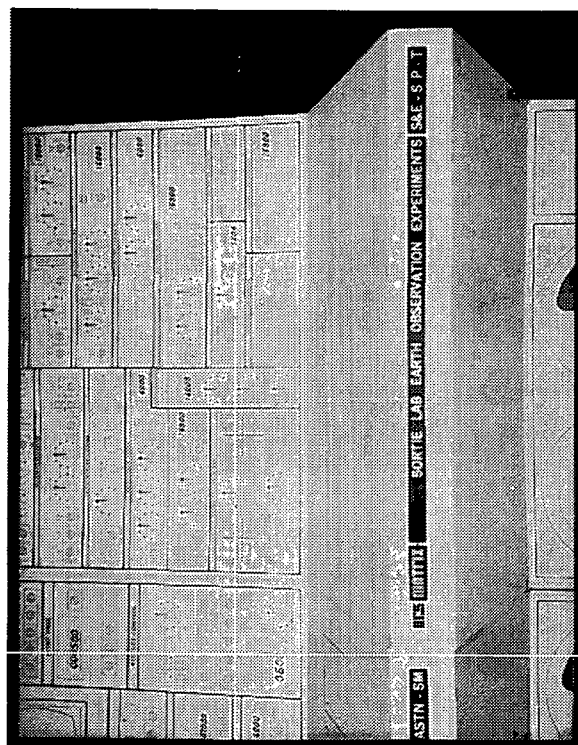
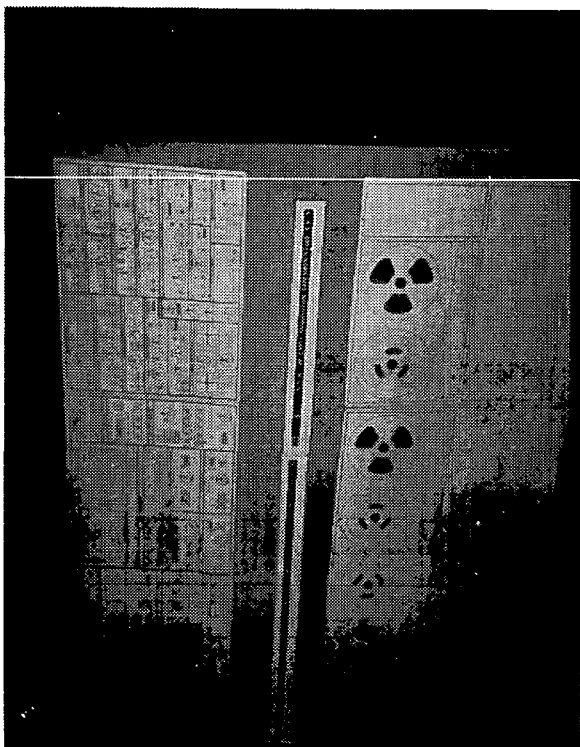
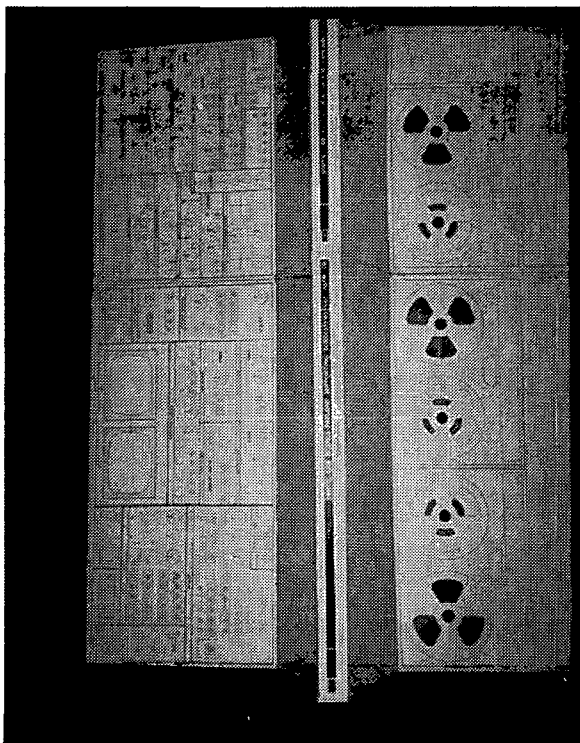
The data presented in this appendix was generated during the analysis which lead to the development of the integrated Sortie Lab Control/Display console concepts reported in Section 4.0 of the report. It is included here to provide explanatory information for those users of the document who are dealing primarily with equipment allocation and design problems. Portions of this data, e.g., the subsystem cost summary data, were developed jointly under this contract and other URS/Matrix study efforts, both contracted and in-house.

PRIMARY EQUIPMENT NUMBER (RAM)	PRIMARY EQUIPMENT NAME	PAYLOADS UTILIZING PRIMARY EQUIPMENT									TASK DEPENDENCY CODES	
		EO-1	EO-2	EO-3	EO-4	EO-5	EO-6	EO-7	EO-8	EO-9	PRIMARY EQUIPMENT	ASSOCIATED C/D EQUIPMENT
280	Metric and Stellar Camera	●	●	●	●	●	●				2.A.17-3	2.B.04-5 & -6
281	Multispectral Camera		●	●	●	●					2.A.17-4	2.B.04-12
282	Multispectral Television			●	●	●	●				2.A.04-2	2.B.04-13
283	Multispectral Scanner		●	●	●	●	●				2.A.19-1	2.B.04-14
284	Passive Microwave Scanner	●	●	●	●	●	●				2.A.19-2	1.B.04-4
285	Microwave Radar		●		●	●					2.A.12-16 & -17	2.B.04-15
286	Multispectral Radiometer	●	●	●	●	●					2.A.21-2	2.B.04-11
287	Microwave Radiometer (3 M and 9 M)	●									2.A.21-1	2.B.04-3
288	Scatterometer/Radiometer	●	●				●				2.A.22-1	2.B.04-2
289	Multispectral Spectrometer	●	●		●						2.A.03-13	2.B.04-10
290	Aeronomy Spectrometer	●									2.A.03-14	2.B.04-17
291	Spectral Polarimeter	●	●	●	●						2.A.23	2.B.04-16
292	Sferics Detector	●				●					2.A.24	2.B.04-8
293	Absorption Spectrometer			●	●						2.A.03-15	2.B.04-9
294A	Optical Radar (Laser Altimeter)		●		●	●					2.A.12-14 & -15	2.B.09
295	Observation Telescope	●	●	●	●	●	●				2.A.01-5	2.B.04-18
296	Telescope Computer	●	●	●	●	●	●				4.B.01-3	*
297	Data Collection System			●	●	●	●				4.D.10	*
298	Cloud Chamber							●	●	●	2.D.02	2.B.04-1
299	Controls and Displays Console	●	●	●	●	●	●				2.B.04	---
300	Data Analysis Equipment-Electronic	●	●	●	●	●	●				*	*
9101	Optical Contamination Monitor	●	●	●	●	●					*	*
9103	Contamination Monitoring Gage	●	●	●	●	●	●				*	*
9105	Mass Spectrometer Sensor	●	●	●	●	●	●				2.A.03-12	*
9102	Contamination Monitor Control Unit	●	●	●	●	●	●				*	*
9104	Contamination Gage Control Unit	●	●	●	●	●	●				*	*
9106	Mass Spectrometer Package	●	●	●	●	●	●				2.A.03-12	*
9422	Film Storage Cabinet	●	●	●	●	●	●	?	?	?	4.D.20	---
9448	Cryogenic System	●	●	●	●	●	●				*	*
SORTIE LAB PAYLOAD CORRELATION	EO-1 Meteorology & the Atmospheric Sciences	x										
	EO-2 World Land Use Mapping		x									
	EO-3 Air & Water Pollution			x								
	EO-4 Resource Recognition & Identification				x							
	EO-5 Natural Disaster Assessment & Anomalies					x						
	EO-6 Ocean Resources						x					
	EO-7 Atmospheric Cloud Physics							x				
	EO-8 Freezing Drop Experiment								x			
	EO-9 Droplet Charging Experiment									x		
RAM MISSION SCHEDULE CORRELATION	EISIN	EISIO	EISIP	EISIQ	EISIR	EISIS	FLIGHT YEAR	FLIGHT NO				
				x			1980	1			x	"EARLY
			x				1981	2		x		
				x			1981	3		x		MISSIONS"
			x				1982	4		x		
					x		1982	5			x	
	x						1983	6	x			
				x			1983	7		x		
			x				1984	8	x			
							1984	9		x		
				x			1984	10			x	
	x					x	1984	11			x	
							1985	12	x			
			x				1985	13		x		
LATER MISSIONS - 1985 & SUBSEQUENT												

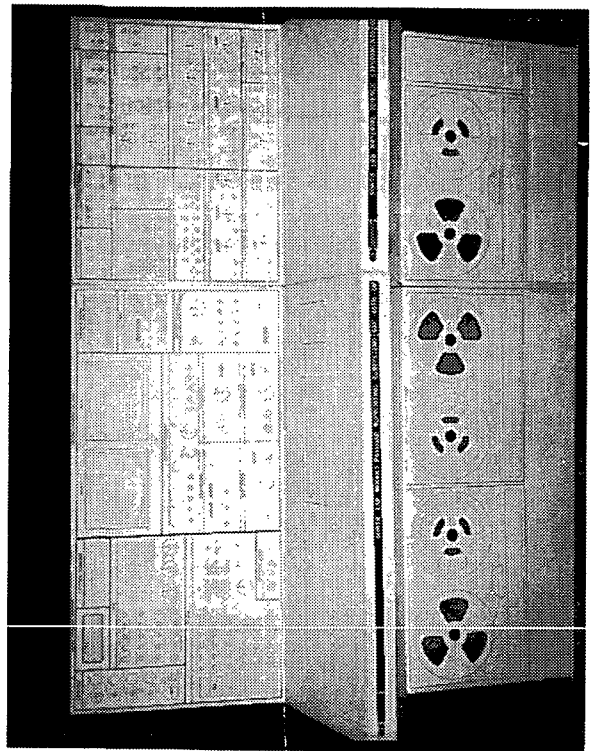
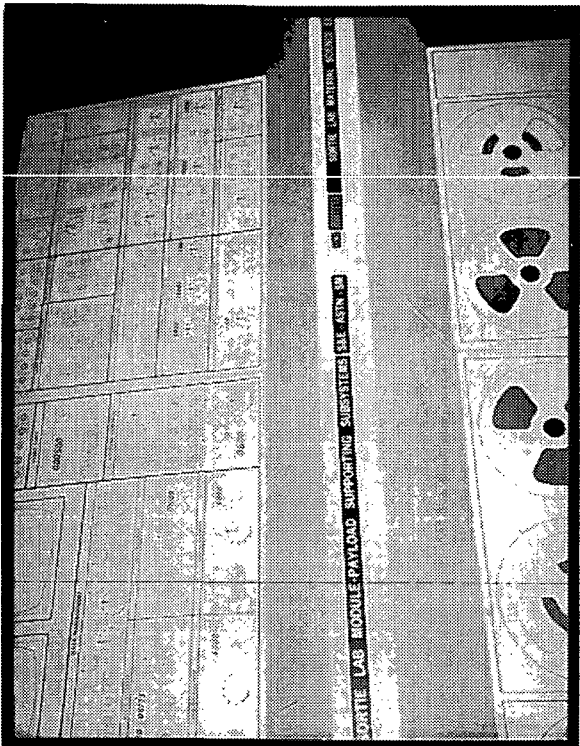
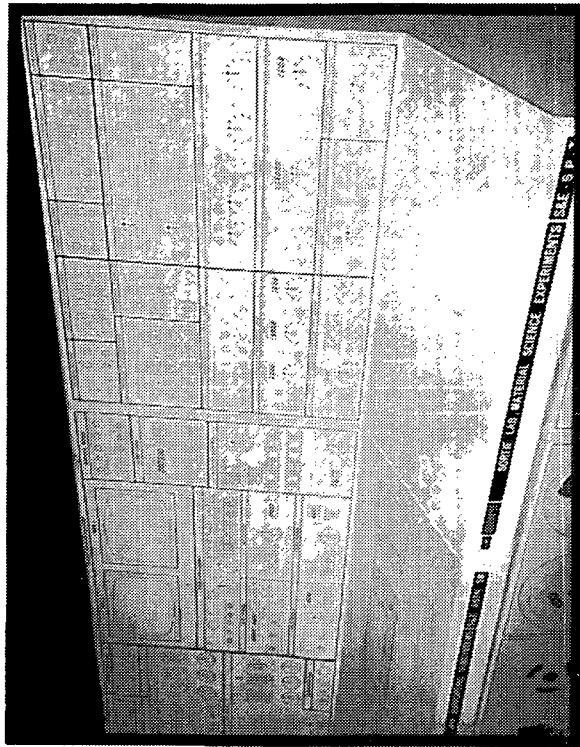
NOTES: ● = Equipment Utilization Planned. ? = Equipment Utilization Possible but not Verified.
* = Task Dependency not Identified. x = Payload/Mission Correlation.

PRIMARY EQUIPMENT NUMBER (BLUE BOOK)	PRIMARY EQUIPMENT NAME						PAYLOADS UTILIZING PRIMARY EQUIPMENT								TASK DEPENDENCY CODES									
							MS-1				MS-2				MS-3				MS-4				PRIMARY EQUIPMENT	ASSOCIATED C/D EQUIPMENT
							1	2	1	2	3	1	2	1	2	1	2							
B-01	Controlled Atmosphere Chamber																2.D.13-4	2.B.06-4						
B-02	Environmental Chamber A-Passive Cooling																2.D.13-1	2.B.06-6						
B-03	Environmental Chamber B-Passive Cooling																2.D.13-2	2.B.06-6						
B-05	Biological Enclosure																2.D.36	2.B.06-3						
B-07	General Purpose Laboratory Installation																4.D.22-1	2.B.06-5						
B-08	Instrumentation and Control Center																2.B.06-2	---						
B-09	Atmosphere Supply and Control System																2.D.15	2.B.06-7						
B-10	Power Conditioning/Distribution System																4.D.13	2.B.06-9						
I-01	Resistance Heated Furnace, 1600°C.																	2.D.24-1	2.B.06-10					
I-04	Heating/Positioning Coils (Set)																	2.D.32	2.B.06-11					
I-07	Dispersion Control System																	2.D.18	2.B.06-12					
I-08	Liquid Sphere Deployment System																	2.D.46	2.B.06-32					
I-11	Zone Melter																	2.D.29	2.B.06-35					
I-12	Czochralski Crystal Puller																	2.D.49	2.B.06-24					
I-13	Susceptor for Silicate Melts																	2.D.45	2.B.06-25					
I-14	High Temperature Calorimeter																	2.A.30-1	2.B.06-29					
I-15	Seed Injector																	2.D.47	2.B.06-26					
I-16	Internal Friction Measuring Device																	2.D.42	2.B.06-30					
I-18	Continuous Electrophoretic Column Assembly																	2.D.37-2	2.B.06-19					
I-19	Buffer Recovery/Waste Disposal System																	2.D.39	2.B.06-20					
I-20	Gas Elimination/Cooling System																	2.D.40	2.B.06-21					
I-21	Lyophilization Apparatus																	2.D.43	2.B.06-23					
E-01	Continuous Atmosphere Analysis Apparatus																	2.D.34	2.B.06-27					
E-02	High Temperature Viewing Device																	2.A.44	2.B.06-28					
E-03	Chill System																	2.D.53	2.B.06-31					
E-04	Motion Picture Camera (16mm.)																	2.A.17-7	---					
E-05	Television Camera																	2.A.04-3	2.B.09					
E-06	Remote Measuring Device (Mass; Dimensions)																	2.A.43	2.B.06-14					
E-07	Mixing Unit-Liquid/Liquid; Liquid/Solid																	2.D.21-1 & -2	2.B.06-13					
E-08	Mixing Unit-Liquid/Gas																	2.D.21-3	2.B.06-15					
E-09	Slip Cast Injection System																	2.D.50	2.B.06-33					
E-10	Vibrator																	2.D.22	2.B.06-16					
E-11	Microscope Stage Attachment																	2.D.56	2.B.06-18					
E-13	UV Densitometer (Microdensitometer)																	2.A.40-2	2.B.06-8					
E-14	Holographic Interferometer																	2.A.39-1	2.B.06-8					
E-15	Model Zone Refiner																	2.D.51	2.B.06-34					
E-17	Variable High Frequency Power Unit																	2.D.52	2.B.06-17					
S-01	Process Control Computer																	2.B.06-1	2.B.06-2					
S-02	Heat Rejection System																	4.D.14	1.C.02-14					
S-04	Materials Analysis Equipment																	2.D.27	---					
S-05	Photographic Processing Lab.																	4.B.08	---					
S-07	Controlled Atmosphere Fluids Storage																	2.D.35	2.B.06-22					
S-08	Accident Control System																	4.E.04-1	1.C.02-13					
SORTIE LAB PAYLOAD/ EXPERIMENT CORRELATION	MS-1 Biological Experiments						(1) Separation of Biologicals	x																
							(2) Preservation of Biologicals		x															
	MS-2 Levitation Experiments						(1) Glasses			x														
							(2) Supercooling				x													
							(3) "Some" Crystals					x												
	MS-3 Furnace Experiments						(1) Composite Materials						x											
							(2) Directional Solidification							x										
	MS-4 Small & Low Temp. Exp'ts						(1) Physics of Fluids								x									
RAM REP. MISSION SCHEDULE CORRELATION							(2) Zone Refining									x								
	MISIE	MISIF	MISIG	MIS2B	FLIGHT YEAR	FLIGHT NO.																		
	x				1980	1	x	x	x	x	x	x	x	x	x			"EARLY"						
	x				1981	2	x	x	x	x	x	x	x	x	x									
	x				1982	3	x	x	x	x	x	x	x	x	x			MISSIONS"						
		x			1984	4	x	x	x	x	x	x	x	x	x									
			x		1986	5	x	x	x	x	x	x	x	x	x									
				x	1988	6	x	x	x	x	x	x	x	x	x									
			x	1989	7	x	x	x	x	x	x	x	x	x										

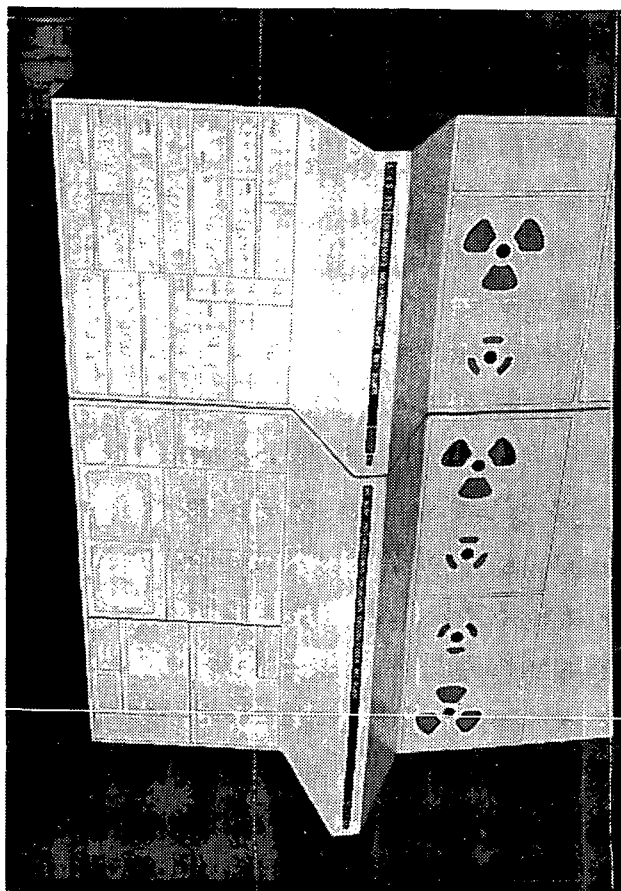
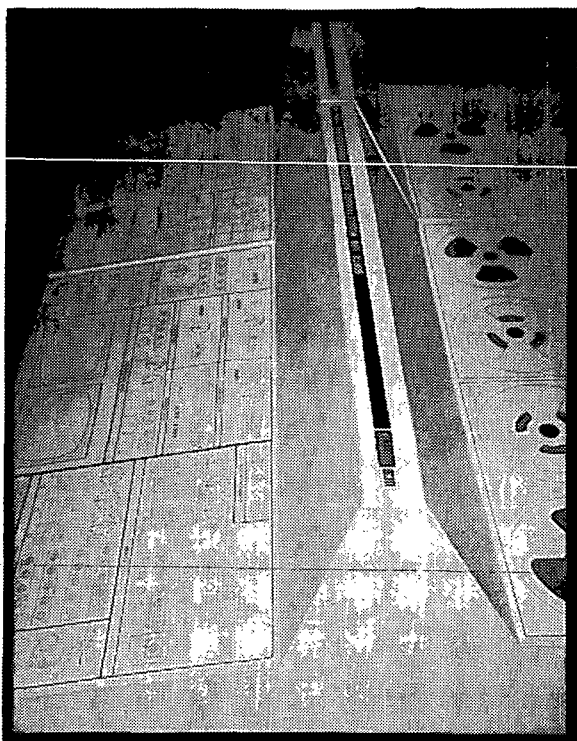
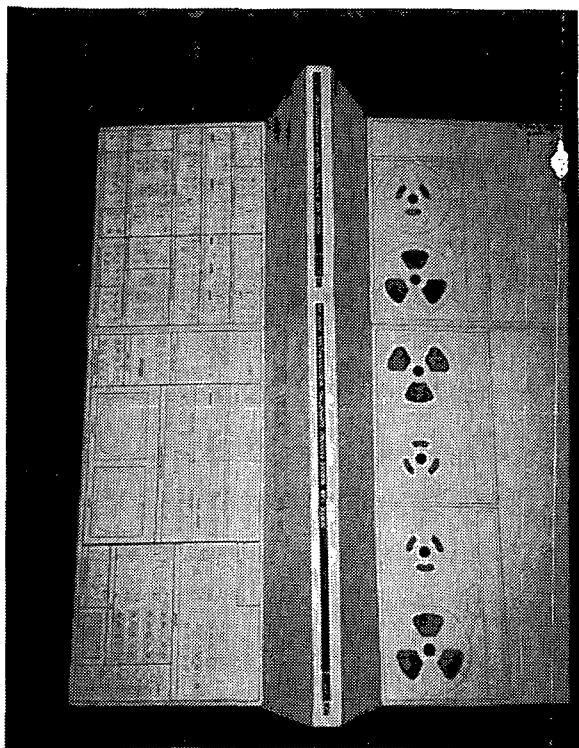
NOTES: ● = Equipment Utilization Planned. ? = Equipment Utilization Possible but not Verified.
x = Payload/Mission Correlation.



Sortie Lab Payloads C&D Console
(Earth Observations Experiments)



Sortie Lab Payloads C&D Console
(Materials Sciences Experiments)



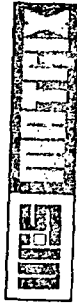
Sortie Lab Payloads C&D Console
(Materials Sciences Experiments
and
Earth Observations Experiments)

SORTIE LAB SUPPORTING SUBSYSTEMS

CONTROL/DISPLAY REQUIREMENTS ANALYSIS

- DATA MANAGEMENT • ATTITUDE/STABILITY CONTROL
- COMMUNICATIONS • ENVIRON. CONTROL/LIFE SUPPORT
- POWER • CAUTION AND WARNING
- LIGHTING

- REF: • SORTIE LAB PROGRAM TASK TEAM REPORTS
- RAM STUDY (PHASE B) TECHNICAL DATA (GDC)
 - SOAR I AND II STUDIES TECHNICAL DATA (MDAC)
 - SKYLAB PROGRAM TECHNICAL DATA (NASA/MSFC)



DESIGNING FOR MAN

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP: DATA MANAGEMENT		
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
	<ul style="list-style-type: none">• Computer/Data Processor• Multipurpose Scientific/Checkout System• External Visual Surveillance of Payload (4 areas)• Voice Recording• Data Recording, Analog• Data Recording, Digital• Event Timing• Video Recording			<ul style="list-style-type: none">• Multipurpose display function keyboard.• Programmable input.• On-off/area select, field of view, angle of view, magnification, and focus.• Start-stop, record, erase, playback and volume.• Start-stop, record, playback, and speed.• Start-stop, record, playback, and speed.• Min/sec slew, start-stop.• Start-stop, record, playback, and speed.	<ul style="list-style-type: none">• Multipurpose video.• Data display video.• Video monitor (2).• Level and recording time remaining.• Tape remaining/status.• Tape remaining/status.• Clock (hr/min/sec), tone alarm.• Tape remaining/status.	<ul style="list-style-type: none">• A/N keyboard/CRT (data mgt./storage).• Keyboard/CRT• CRT• Experiment communications.• Experiment/mission data.• Experiment/mission data.• Experiment function timing



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP: COMMUNICATIONS		
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
	<ul style="list-style-type: none">• Voice - Interstation (Cabin)<ul style="list-style-type: none">- Orbiter- Ground Station• Command/Experiment Data• Video Data• Computer Data• Text/Graphics• Facsimile			<ul style="list-style-type: none">• On-off/mode,• Station select,• Channel select. (Part of Data Management System) (Part of Data Management System)		<ul style="list-style-type: none">• VHF and K-band/S-band (via Orbiter).• To/from Orbiter• S-band (via Orbiter)• See Data Management• TBD• TBD

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP:		POWER SYSTEM	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS		
	• Fuel Cell O ₂ Input Temperature			• Activate displays for monitoring fuel cell O ₂ input temp.	• O ₂ input temperature monitor. • Automatic indicator for out-of-tolerance temp.	• Display should indicate temperature in degrees fahrenheit.		
	• Fuel Cell H ₂ Input Temperature			• Activate display for monitoring fuel cell H ₂ input temp.	• H ₂ input temperature monitor. • Automatic indicator for out-of-tolerance temp.	• Display should indicate temperature in degrees fahrenheit.		
	• Fuel Cell H ₂ O Output Temperature			• Activate display for monitoring fuel cell H ₂ O output temp.	• H ₂ O output temperature monitor. • Automatic indicator for out-of-tolerance temp.	• Display should indicate temperature in degrees fahrenheit.		
	• Fuel Cell Internal Temperature			• Activate display for monitoring fuel cell internal temperature.	• Internal temperature monitor. • Automatic indicator for out-of-tolerance temp.	• Display should indicate temperature in degrees fahrenheit.		
	• Fuel Cell O ₂ Input Pressure			• Activate display for monitoring O ₂ input pressure.	• O ₂ input pressure monitor. • Automatic indicator for out-of-tolerance pressure.	• Display should indicate input pressure in PSI.		

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		POWER SYSTEM (CONTINUED)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
	• Fuel Cell H ₂ Input Pressure			• Activate display for monitoring H ₂ input pressure.	• H ₂ input pressure monitor. • Automatic indicator for out-of-tolerance pressure.	• Display should indicate input pressure in PSI.	
	• Fuel Cell O ₂ Flow Rate			• Activate display for monitoring O ₂ flow rate.	• O ₂ flow rate monitor.	• Flow rate should be displayed in CFM.	
	• Fuel Cell H ₂ Flow Rate			• Activate display for monitoring H ₂ flow rate.	• H ₂ flow rate monitor.	• Flow rate should be displayed in CFM.	
	• Fuel Cell H ₂ O Output Flow Rate			• Activate display for monitoring H ₂ O flow rate.	• H ₂ O flow rate monitor.	• Flow rate should be displayed in CFM.	
	• Fuel Cell O ₂ Heater			• Activate/deactivate heater.	• Indicate when heater to operating temperature. • Automatic indicator for heater failure.	• Control should be discrete.	
	• Fuel Cell H ₂ Heater			• Activate/deactivate heater.	• Indicate when heater to operating temperature. • Automatic indicator for heater failure.	• Control should be discrete.	

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		POWER SYSTEM (CONTINUED)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
	• Fuel Cell O ₂ Inlet Valve			• Open/close valve	• Indicate valve status	• Control should be discrete, display should show open, closed, and in-transition.	
	• Fuel Cell H ₂ Inlet Valve			• Open/close valve	• Indicate valve status	• Control should be discrete, display should show open, closed, and in-transition.	
	• Fuel Cell Purge			• Open and close cell O ₂ and H ₂ purge valves	• Indicate status of valves.	• One control may open and close both valves; display should indicate for each valve whether it is open, closed, or in transition	
	• Fuel Cell Output Voltage (28vdc)			N/A	• Display output voltage (vdc)		
	• Fuel Cell Output Power (28vdc)			N/A	• Display output power (watts)		
	• Fuel Cell Output Voltage (115 vac)			N/A	• Display output voltage (vac)		
	• Fuel Cell Output Power (115 vac)			N/A	• Display output power (watts)		



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP: LIGHTING SYSTEM		
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
	<ul style="list-style-type: none">● Cabin Lighting<ul style="list-style-type: none">- Floodlights● External Lighting<ul style="list-style-type: none">- Floodlights● Panel Lighting● Display Lighting● Lighting Test<ul style="list-style-type: none">- Attitude- Caution & Warning Displays- Status- Numeric			<ul style="list-style-type: none">● Adjust cabin lighting● Activate/deactivate● External floodlights● Adjust panel lighting● Adjust display lighting.● Select and actuate light test.	<ul style="list-style-type: none">● N/A● N/A● N/A● N/A● Display test feedback.	<ul style="list-style-type: none">● Allows variable lighting control capability.● Allows observation of externally mounted hardware.● Allows variable control of console back-lighted EL.● Allows variable control of back-lighted displays.● Provides capability of momentary testing panels lights and displays with an unregulated fixed power supply.

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP: ATTITUDE/STABILITY CONTROL	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
	<ul style="list-style-type: none"> Vehicle Orientation Monitoring <ul style="list-style-type: none"> - Pitch - Yaw - Roll - Orbital Plane Error Payload Platform Stability Star Tracker Pointing <ul style="list-style-type: none"> - Pitch - Yaw Sun Sensor CMG System (3 Systems) Momentum Management 			<ul style="list-style-type: none"> Mode Select <ul style="list-style-type: none"> - Orbiter - Sortie Lab - Payload Pitch, yaw, roll control input (attitudes and rates) Mode Select <ul style="list-style-type: none"> - Manual (pitch & yaw) - Automatic 	<ul style="list-style-type: none"> Pitch, yaw, roll, and Orbital Plane in sec. Same as above Pitch and yaw coordinates Temp., current, speed 	<ul style="list-style-type: none"> Monitor Orbiter/Sortie Lab and payload attitude/stability Same as above Experiment reference See Earth Obs. Data System status If required

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP: ENVIRONMENTAL CONTROL/LIFE SUPPORT		
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
	<ul style="list-style-type: none">• Orbiter/Sortie Lab Press. Equilization• Circulation Fan(s)• Temperature Maintenance<ul style="list-style-type: none">- Coolant Flow- Heater• Humidity Maintenance• O₂/N₂ Part. Press.• Cabin Pressure Relief• Cabin Temp. Bypass• Payload Coolant Control• Radiator Deployment			<ul style="list-style-type: none">• Open-close• On-off• On-off/flow rate• On-off/regulate• On-off/regulate• On-off/regulate• On-off/variable• Open close• Pump, on-off (2)• By pass, on-off (2)• Power• Flow rate• Deploy/retract	<ul style="list-style-type: none">• Temp. °F• Rel. humidity• O₂/N₂ PP monitor• Coolant temp., in/out payload temp.	<ul style="list-style-type: none">• Balance pressures• Heat exchanger• Automatic after setting• Automatic after setting• To overboard vent• To by pass air conditioning sys.• Maintain temp. stability of payload on pallet.• Erect booms, etc.

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP: CAUTION AND WARNING	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS *	DISPLAYS **	REMARKS
	Temperature - Radiator - Air Cooling System - Experiment(s)				Caution	Out-of-Tol.
	Pressure (Atmosphere)				Caution/Warning	Out-of-Tol.
	Contamination (Atmosphere)				Caution/Warning	Out-of-Tol.
	Humidity				Caution/Warning	Out-of-Tol.
	Acceleration				Caution/Warning	Out-of-Tol.
	Radiation				Caution/Warning	Out-of-Tol.
	Airlock(s)				Caution/Warning	Out-of-Tol.
	Attitude Control				Warning	Non-programmed opening
	Power - Fuel Cell Press.(s) - Fuel Cell Temp.(s) - Voltage, Amperage				Caution/Warning	Experiment stability
	Shuttle Status				Caution/Warning	Out-of-Tol.
*Signal	hardwired form appropriate sensors				Caution/Warning	Orbiter Condition
**Audio	indication/Visual Display					

SORTIE LAB EXPERIMENTS
CONTROL/DISPLAY REQUIREMENTS ANALYSIS

• EARTH OBSERVATIONS

REF:

- BLUE BOOK, 1/15/71, Vol. IV
- SORTIE LAB DOC., TASK 4.1.3.2, .3, .4
- SKYLAB ODB, Vol. I, Part 2, Rev. A.

• MATERIAL SCIENCES

REF:

- BLUE BOOK, 1/15/71, Vol. VI
- SORTIE LAB DOC., TASK 4.1.3.3.2, .3, .4

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observations	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
280	Metric & Stellar Camera	E0-1 -2 -3 -4 -5 -6		Power Metric camera on/off Met. cam. spectral range adjust Met. cam. frame rate select Stellar camera on/off (4) S.C. (4) spectral range adjust S.C. frames rate select (4)	Power on M.C. operating status M.C. spectral range M.C. frame rate M.C. frames remaining Stellar camera (4) operating status S.C. spectral range(4) S.C. frame rate (4) S.C. frames remain- ing (4)	<ul style="list-style-type: none">4 stellar cameras within the Metric camera housing.Some sources say 2 Metric cameras are required.	
281	Multispectral Camera	E0-2 -3 -4 -5		Power On/off (6) Filter select (6) Exposure time select (1) Frame rate select (1)	Power on Operating status (6) Filter status (6) Exposure time (1) Frames remaining (1) Frame rate (1)	<ul style="list-style-type: none">6 separate cameras in set.Cameras are synchronizedSkylab S-140 applicable	
282	Multispectral TV	E0-3 -4 -5 -6		Power On/off Slitfocus adjust Collimation adjust Line scan speed select (3) Spectral band select (12) Bandwidth select Recorder on/off Data digitizer on/off	Power on Operating status Slit focus Collimation status Scan speed Spectral band (12) Bandwidth Recorder frames remaining Digitizer oper. status	<ul style="list-style-type: none">Camera only; video display not included here.	

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observations (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
283A	Multispectral Scanner - External	E0-2		Power On/off Mode select Alignment mode select	Power on Operating status Operating mode Alignment thermal Visible alignment Alignment ready Cal. source	● Should be basically similar to Skylab S-192 See ODB vol. I for S-192 and ESES.	
283B	Multispectral Scanner - Internal	-3		Calibration source select			
283C	Multispectral Scanner - Electronics	-4		Cal. source intensity select	Cal. source intensity		
		-5		Recorder on/off	Recorder status Cryogenics/cooling status		
284A	Passive Microwave Scanner - Antenna	E0-1		Power On/off Calibration mode select	Power on Operating status Cal. mode	● Should be equivalent to Skylab S-194, L-Band Radiometer. ● May use 2 radiometers of different frequencies.	
284B	Passive Microwave Scanner - Electronics	-2		Cal. time interval select	Cal. time interval		
		-3		Recorder on/off	Recorder status CRT video Frequency		
		-4		CRT on/off			
		-5		Frequency select (?)			
285A	Microwave Radar - Antenna	E0-2		Power On/off	Power on Operating status Recorder status	● Limited description available; some elements of Skylab S-193 may be applicable.	
285B	Microwave Radar - Electronics	-4		Recorder on/off			
285C	Microwave Radar - Film Recorder	-5					



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observations (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
286	Multispectral Radiometer	E0-1 -2 -3 -4 -5		Power On/off Band select Bandwidth select Look angle select Pointing	Power on Operating status Band Bandwidth Look angle Video and/or cross & along track coordinates.		
287A	Microwave Radiometer 9M Antenna	E0-1		Power 9M on/off 3M on/off	Power on 9M operating status 3M operating status	• Portions of Skylab S-193 descriptions may be applicable.	
287B	9M Antenna Electronics			9M band select	9M band		
287C	3M Antenna			3M band select	3M band		
287D	3M Antenna Electronics			Antennae pointing (2) Beamwidth select ?	Antennae angles (2) Beamwidths (2) ? Sensed temperatures		
288A	Scatterometer/Radiometer	E0-1		Power On/off scatter.	Power on Operating status, scatterometer.	• Portions of Skylab S-193 description is applicable.	
288B	44 inch Antenna	-2 -6		Radiometer on/off	Radiometer oper. status		
288C	Mechanical Scanner Electronics			S/R scan mode select S/R x-track scan angle select Polarization select Altimeter on/off Altimeter mode select Altimeter range select	S/R scan mode S/R x-track scan angle S/R polarization S/R malfunctions Alt. oper. status Alt. mode Alt. range		

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observations (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
289A 298	Multispectral Spectrometer • Optics • Electronics	E0-1 -2 -4		Power Spectrometer on/off Imaging system on/off Calibration on/off Spectral band select Cooling initiate Telescope alignment	Power on Spect. operating status Imaging (video?) Calibration status Spectral band Temperature Alignment status	<ul style="list-style-type: none">• Skylab S-191 is partially applicable.• The image display is probably the same as for the observation telescope (295)	
290A 290B 290C	Aeronomy Spectrometer • 1-100 nm • 0.1 - 1 nm • Electronics	E0-1		Power Interferometer on/off Sc/Gr. Spectrom. on/off Calibration on/off Telescope alignment Recorder on/off	Power on Interf. Oper. Status Sc/Gr. Spec. Oper. status Calibration status Alignment status Recorder status	<ul style="list-style-type: none">• Also used in space physics• Pointing & video is through the Observation Telescope (295)	
291	Spectral Polarimeter	E0-1 -2 -3 -4		Power Polarimeter on/off Telescope alignment Camera actuate Recorder on/off	Power on Operating status Alignment status Camera status Recorder status	<ul style="list-style-type: none">• Boresighted with Observation Telescope (295)	
292A 292B	Sferics Detector • Antenna • Electronics	E0-1 -5		Power On/off Amplifier gain Pass Band select Beam width select	Power on Operating status Amplifier gain Pass band Beam width		

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observations (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS	
293	Absorption Spectrometer	E0-3 -4		Power On/off Calibration on/o-f Spectral mask select	Power on Operating status Calibration status Spectral masks in use.		
294A	Optical Radar (Laser Altimeter)	E0-2 -4 -5		Power On/off Collimation test Camera on/off Tape Recorder on/off	Power on Operating status Collimation status Range measure/video(?) Camera status T.R. status. Frames remaining	<ul style="list-style-type: none">Used in conjunction with Metric Camera (280) when photography desired.	
295	Observation Telescope	E0-1 -2 -3 -4 -5 -6		Power Magnification select Mirror pointing Camera on/off TV camera on/off Spectrometer align. Other sensor align.	Power on Magnification Gimbal angles Camera status Film remaining TV status TV video display Spect. alignment Sensor alignment Binocular viewer	<ul style="list-style-type: none">Similar in some respects to V/TS of Skylab S-191.Number of other sensors to be aligned with the Obser. Telescope is unknown.	
296	Telescope Computer	E0-1 -2 -3 -4 -5 -6		Power Computer on/off Computer coordinate input select	Power on Comp. Operating status Coordinates	<ul style="list-style-type: none">Probably will use keyboard, but not verifiable.	

SUBSYSTEM/EXP:					Earth Observation (Continued)	
SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE					SUBSYSTEM/EXP:	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
297	Data Collection System	E0-3 -4 -5 -6		Power On/off (receivers) On/off (Transmitters)	Power on Operating status Xmtr. Operating status Malfunctions	<ul style="list-style-type: none">• Similar to ERTS• Primarily automatic
298	Cloud Chamber	E0-7 -8 -9		Power Microscope pointing Microscope focus Drop insertion Cameras on/off Pressure select Temperature select	Power on Visual Visual Visual Cameras oper. status Cameras frames remaining. Pressure Temperature G-level	<ul style="list-style-type: none">• Direct interface probably required.
300	Data Analysis Equipment - Electronic	E0-1 -2 -3 -4 -5 -6		Power Tape transport on/off Computer keyboard Film projector on/off Film processor on/off	Power on Tape Trans. status Projector status Processor status	<ul style="list-style-type: none">• Uses many of displays listed under #299.
299	Controls and Displays	E0-1 -2 -3 -4 -5 -6		Console Power CRT scopes voltage monitor select Computer input Diffraction gratings select	Power on/ CRT moving displays CRT scopes Multichannel oscillo- scope Comp. operating status Diff. grating selected	<ul style="list-style-type: none">• For all sensors that output in analog or digital format.• A summary of requirements listed under other equipment numbers.

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observation (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS	
299	Controls and Displays (Continued)			Apertures select Filters select Airlock extenders operate Timing inputs Command inputs Level select Sensor select Auto/manual select Exposure time select Frame rate select Focus select Alignment Antenna position Heater input	Apertures selected Filters selected Airlock extenders position/status Sequences Level status Sensors oper. status Mode Exposure times Frame rates Focus Alignment Antenna orientation EC/LS status Heater status CRT-alphanumeric CRT-triggered sweep Video imagery		
280B	Metric Camera Contamination Cover	EO-1 -2 -3 -4 -5 -6					
280C	Stellar Camera Contamination Cover						
281B	Multispectral Camera Contamination Cover						
282B	Multispectral TV - Contamination Cover						
291B	Spectral Polimeter Contamination Cover						

- No active components, therefore no C/D requirements.
- If palletized, remote operation will require cover(s) position status indicators, and controls for removing/replacing the covers on the sensors.

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observation (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
2948	Optical Radar Contamination Cover	E0-1 -2 -3 -4 -5 -6				• Same comments as far #2808 thru 291B.	
294C	Optical Radar Contamination Cover						
2958	Observation Telescope Contamination Cover						
295C	Observation Telescope Contamination Cover						
9101	Optical Contamination Monitor	E0-1 -2 -3 -4 -5 -6				• Has no power requirements, but may require C/D. No description available.	
9103	Contamination Monitoring Gage	E0-1 -2 -3 -4 -5 -6				• Has no power requirements, but may require C/D. No description available.	
9105	Mass Spectrometer Sensor	E0-1 -2 -3 -4 -5 -6				• Has no power requirements, but may require C/D. No description available.	

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP: Earth Observation (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
9401A	Microwave Radar - Gimbal	E0-2 -4 -5				● C/D requirements, if any, are probably included under the primary equipment. No power requirements listed.
9403A	Gimbal - #286/#291	E0-1 -2 -3 -4 -5				
9409A	Scatterometer/Radiometer Gimbal	E0-2 -6				
9405A	Microwave Radiometer - 9M Antenna Gimbal	E0-1				
9407A	Microwave Radiometer - 3M Antenna Gimbal	E0-1				
9413A	Absorption Spectrometer Gimbal	E0-4				
9401B	Microwave Radar - Gimbal Control	E0-2 -3 -4 -5				
9403B	Gimbal Control - #286/291	E0-1 -2 -3 -4 -5 -6				

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:			Earth Observation (Continued)
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS	
9405B	Microwave Radar - 9M Antenna Gimbal Control	E0-1				• C/D requirements, if any, are probably included under the primary equipment. No power requirements listed.	
9409B	Scatterometer/Radiometer Gimbal Control	E0-1 -2 -6					
9413B	Absorption Spectrometer Gimbal Control	E0-4					
9102	Contamination Monitor Control Unit	E0-1 -2 -3 -4 -5 -6		Power On/off	Power on Operating status Contamination data	• No description available; it does have power req'ts, and data output.	
9104	Contamination Gage Control Unit	E0-1 -2 -3 -4 -5 -6		Power On/off	Power on Operating status Contamination data	• No description available; it does have power req'ts, and data output.	
9106	Mass Spectrometer Package	E0-1 -2 -3 -4 -5 -6		Power On/off	Power On Operating status Spectral Data (?)	• No description available; it does have power req'ts, and data output.	

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Earth Observations (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP	CONTROLS	DISPLAYS	REMARKS	
9422	Film Storage Cabinet	E0-1 -2 -3 -4 -5 -6				• Structural; no C/D req'ts.	
9448	Cryogenic System	E0-2 -3 -4 -5 -6		Power	Power on	• Has no data requirements listed. Should include basic power and status, C/D. • Passive; no C/D req'ts except for processing. See #300.	
9432	Film	E0-1					
9433	Film	E0-2					
9434	Film	E0-3					
9435	Film	E0-4					
9436	Film	E0-5					
9437	Film	E0-6					
	<u>DEPLOYMENT BOOMS</u>						
9417	Passive Microwave Scanner	E0-1 thru E0-6				• C/D requirements, if any, are probably included under the primary equipment. No power or data requirements listed.	
9418	Microwave Radar	E0-2, -4, -5					
9419	Microwave Radiometer - 9M	E0-1					



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP: Earth Observations (Continued)		
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
	<u>DEPLOYMENT BOOMS (Cont'd)</u>					
9420	Microwave Radiometer - 3M	E0-1				
9421	Scatterometer/Radiometer	E0-1	-2, -6			
9447	Multispectral Scanner Contamination Cover	E0-2	-3, -5, -6			• Same comments as for #280B thru #291B.
293B	Absorption Spectrometer Contamination Cover	E0-3	-4			

SUBSYSTEM/EXP: Material Sciences			
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SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP: Material Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
B-03	Environmental Chamber B-pressure cooling	MS-2 MS-3 MS-4	1,2 1,2 1	Same requirements as unit B-02, except that Unit I-04 imposes no C/D requirements		
B-05	Biological Enclosure	MS-1	1,2 1	Power on/off Gas circulation on/off Emergency containment U.V. lamps on/off Phenol/formaldehyde Shower	Power on Operating status Gas circ. system status Safety & hazard control status Pressure level U.V. lamp status Shower status	<ul style="list-style-type: none"> UV lamp and disinfectant shower may be activated automatically. Heat sterilization unit in gas recirculation system may need separate C/D. May not be under remote control
B-07	General Purpose Lab Installation	MS-1 MS-2 MS-3 MS-4	1 1 2 1,2	Outlets power Gas supply Vacuum pull	Outlets power Gas supply status Vacuum pull status	
B-08	Instrumentation & Control Center	MS-1 MS-2 MS-3	1,2 1,2,3 1,2	PANELS Inputs to P.C. Computer S-01. Overrides to auto. controls. Controls for data recording. On/off for sensors Sensor adjustments	PANELS S-01 operating status Auto control status Displays for outputs of sensors Recorder status Sensor status Data reduction status	<ul style="list-style-type: none"> NOTE: This is the basic C/D unit for MS exp'ts.



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP: Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS
B-09	Atmosphere Supply and Control System	MS-1 MS-2 MS-4	1,2 1,2,3 1,2	TU & UTR on/off Voice comm. on/off & adjust. Voice recording on/off Safety device & acc. Control syst. on/off	Visual displays, inc. CCTV & VTR Voice comm. status Voice recording status Safety/acc status displays. Power on Operating status Valves status Torr level Vacuum pull status Gas mixing units status Gas recirculation system status.	<ul style="list-style-type: none"> Vacuum not by pump. uses duct/valves to space.
B-10	Power Conditioning and Distribution Systems	MS-1 MS-2 MS-3 MS-4	1,2 1,2,3 1,2	On/off Main Pwr Supply connected Pwr. distribution to exp't. units. Voltage conversions Frequency conversions AC/DC Storage Btry connect Emergency shutdown B-10 self test/test	Operating status Main Pwr supply connected. Pwr. distribution to exp't. units - status Voltage, each unit Frequency, each unit AC/DC status, each unit Btry status Discharge/Recharge Status. Safety/Hazard B-10 test status.	<ul style="list-style-type: none"> Number of exp't. units which may be connected simultaneously is unknown.

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
I-01	Resistance Heated Furnace 1600 K	MS-2 MS-3	1 1.2	On/off Temperature adj.	Operating status Temperature	<ul style="list-style-type: none">Some requirements are duplicative of those listed in B-01, B-02, B-03.	
I-04	Heating and Positioning Coils (Set)	MS-2 MS-3	3 2	Power On/off Power level adjust Heating select? Positioning select? Cooling select	Power on Operating status Power level Heating status? Positioning status: Cooling status Temperature	<ul style="list-style-type: none">See note in I-01.May also be used in B-07.Number of coils which may be in use simultaneously is unknown.May not require separate action for heating vs. positioning - not known.	
I-07	Dispersion Control Systems	MS-3 MS-4	2 1	Power On/off Programming keys for dispersion adj.	Power on Operating status Input status		
I-08	Liquid Sphere Deployment System	MS-3	2	Sphere detachment actuate Detachment mode adj.	Orifice pressure Sphere detachment status. Detachment mode status operating status.	<ul style="list-style-type: none">Supposed to be used only with unit B-06, which is not scheduled for use on Sortie lab.	
I-12	Czochralski Crystal Puller	MS-2	1	Power On/off Insertion/removal select Rate adjust	Power on Operating status Inseption/removal select status Rate status	<ul style="list-style-type: none">C/D req'ts same as for I-15.May all be preprogrammed	

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
I-13	Susceptor for Silicate Melts	MS-2	1	Power On/off Temperature select	Power on Operating status Temperature (?)	• Temp. display may not be required; uses induction coil for heating.	
I-14	High Temperature Calorimeter	MS-2	2	Power On/off Temperature select (2)	Power on Operating status Temperature (2) Power Δ integral	• Uses 2 separately controlled cavities.	
I-15	Seed Injector	MS-2	1	On/off (magnets) Insertion/removal select Rate adjust	Operating status Insertion/removal select status Rate status	• C/D req'ts same as for I-12 • May all be preprogrammed.	
I-16	Internal Friction Measuring Device	MS-2	2	Power On/off Oscillation frequency select	Power on On/off Osc. frequency select status Resonant frequency Power drain Interval temperature	• Multiple columns, Number unknown, can be operated independently.	
I-18	Continuous Electrophoretic Column Assembly.	MS-1	1	Power On/off Sample injection actuate Buffer recovery actuate (I-14) Gas elimination actuate (I-20) Densitometer actuate (E-13) Interferometer actuate (E-14)	Power on Operating status Sample injection status Buffer recovery status (I-14) Gas elimination status (I-20) Densitometer status (E-13) Interferometer status (E-14)	Probably will be under automatic control of D.C. computer (S-01). May be 2 assy's; one in B-05 and one in B-07.	

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS		
I-19	Buffer Recovery/Waste Disposal System	MS-1	1	Power On/off Recovery initiate Sterilization initiate Carburization initiate	Power on Operating status Recovery status Sterilization status Carburization status	} May be preprogrammed and/or done manually		
I-20	Gas Elimination/Cooling System	MS-1	1	Power On/off Degassing initiate Cooling initiate Recirculation initiate Buffer routing select	Power on Operating status Degassing status Cooling status Buffer temperature Recirculation status Buffer routing		} May be preprogrammed and/or done manually.	
I-21	Lyophilization Apparatus	MS-1	2	Power On/off Time cycle set Temperature cycle set	Power on Operating status Time cycle Temp. cycle Time remaining Temperature Heat pump status Mechanical stoppering device status.	<ul style="list-style-type: none">Primarily automatic in operation.Will use space vacuum in airlock or thru duct.		
I-22	Molds, Cavities and Crucibles	MS-2 MS-3 MS-4	1 1,2 1			<ul style="list-style-type: none">Passive; no C/D req'ts.		
I-23	Miscellaneous Internal Attachments	MS-2 MS-3	1 1.2			<ul style="list-style-type: none">Structural; no C/D req'ts.		



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS		
E-01	Continuous Atmosphere Analysis Apparatus	MS-2	2,3	Power Chromatograph on/off Spectrometer on/off	Power on Chromatograph operating status Spectrometer, operating status Impurity count Impurity type			
E-02	High Temperature Viewing Device	MS-2	3	Power Laser on/off Display adjust. Photograph actuate	Power on Laser oper. status Holographic display			
E-03	Chill System	MS-3	2	Power On/off Cooling/Cooling Jet select	Power on Operating status Cooling/Cooling Jet select status Cooling Jet Warning Pump status	<ul style="list-style-type: none">• Movable unit for multiple location use; may not be susceptible to centralized C/D.• May require audible alarm.		
E-04	Motion Picture Camera (16mm)	MS-2 MS-3 MS-4	1 2 1,2	Power On/off Lens changing Focus adjust	Power on Operating status Lens in use Focus in use	<ul style="list-style-type: none">• Electrically operated• Multiple cameras planned• Movable; C/D centralization difficult.		
E-05	TV Camera	MS-1 MS-2 MS-3 MS-4	1 1 2 1,2	Power On/off Focus adjust	Power on Operating status Focus Video monitor	<ul style="list-style-type: none">• All notes same as E-04• Pan/tilt provisions unknown.		
E-06	Remote Measuring (Mass, Dimensions)	MS-2 MS-3	1,2,3 2	Power On/off	Power on Operating status	<ul style="list-style-type: none">• Description unavailable; believed to be the device for illuminating/reviewing holograms made with E-02.		

SUBSYSTEM/EXP:					Materials Sciences (Continued)	
SUBSYSTEM PARAMETERS/ EQUIPMENT NOMENCLATURE					SUBSYSTEM/EXP:	
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SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS					SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS		
E-10	Vibrator (Continued)			Power On/off Frequency select Power On/off Frequency select?	Power on Operating status Frequency Power on Operating status Frequency?	<ul style="list-style-type: none">Mechanical, variable low-frequency shaker, large.Ultrasonic transducerRemote C/D is probably not practical.		
E-11	Microscope Stage Attachment	MS-2 MS-4	1 2	Power On/off Heating select Cooling select	Power on Operating status Temperature	<ul style="list-style-type: none">Said to be programmableUsed w/microscope in either B-07 or S-04.		
E-13	UV Densitometer (micro)	MS-1	1	Power On/off Scan adjust	Power on Operating status Scan mode UV adsorption variation data	<ul style="list-style-type: none">Used only w/unit I-18		
E-14	Holographic Interferometer	MS-1	1	Power On/off (laser) Time Δ select Holocamera initiate Display adjust?	Power on Operating status, laser Time Δ Holocamera status Holographic display?	<ul style="list-style-type: none">Laser may be the same as in E-06 and E-02.Used only w/unit I-18.		
E-17	Variable High Frequency Power Unit	MS-2 MS-3	1,3 1,2	Power on/off Frequency select Outlet select for low/high power (2) B-10 connection mode select Power output select	Power on Frequency Outlets/power select --- B-10 connection mode Power level	<ul style="list-style-type: none">Portableindependent; can use both simultaneously		



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
E-18	External Molds and Containers	MS-3	1,2			Passive; containers for attachment to other containers. No C/D requirements.	
E-19	Minor External Components	MS-3 MS-4	1,2 1,2			Structural only; no C/D requirements	
S-01	Process Control Computer	MS-2 MS-3	1,3 2	Power	Power on	<ul style="list-style-type: none">All other C/D requirements are included in B-08.	
S-02	Heat Rejection System	TBD	TBD	Power On/off Active cooling rate select	Power on Operating status Regulator status Radiator status Cooling rate Temperatures	<ul style="list-style-type: none">Actual system not defined. C/D req'ts. shown are estimates of potential req'ts.	
S-03	Cleanup and Refurbishment Equipment	MS-2 MS-3	1,3 1,2			<ul style="list-style-type: none">Portable tools; probably non-powered. Assume no C/D req'ts.	
S-04	Materials Analysis Equipment	MS-4	2	Metallograph power Metallograph on/off Saws on/off Polishers on/off X-ray diffraction unit power X-ray diffraction on/off pH meter on/off Zero-G balance on/off (?)	Met. power on Met. operating status Saws operating status Polishers operating status X-ray diff. power on X-ray diff. oper. status pH meter oper. status Zero-G balance operating status (?) Metallographic data	<ul style="list-style-type: none">All are individual units and C/D should be integral w/the unit (except possibly the X-ray diffraction equipment. Will normally be used at B-07, plugging into distributed power.	

SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
S-04	Materials Analysis Equipment (Continued)						
S-05	Photographic Processing Lab	TBD	TBD	Power Processing tank power Processing tank on/off Processing tank circulation select PT temp. select Film dryer power Film dryer on/off F.D. temp. select F.D. circ. select Printer power Printer on/off Viewer power Viewer on/off	X-ray diff. data pH data zero-G balance data Power on Proc. tank power on Proc. tank oper. status Proc. tank circulation rate PT temperature Film dryer power on F.D. operating status F.D. temperature F.D. circulation rate Printer power on Printer oper. status Viewer power on Viewer oper. status Viewer video	<ul style="list-style-type: none">• Likely to be a multidiscipline item of equipment.• Could easily be a separate unit of the work area, w/no console C/D req'ts except power. Is not used during exp't operations.	
S-06	Open Materials and Fluids Storage	MS-2 MS-3 MS-4	1,2,3 1,2 1			<ul style="list-style-type: none">• Storage unit only; imposes no C/D requirements	
S-07	Controlled Atmosphere Fluids Storage	MS-1	1,2	Power On/off Inert gas supply on/off Gas pressure select Temp. control on/off (2)	Power on Operating status Inert gas oper. status Gas pressure Temp. control oper. status (2)	<ul style="list-style-type: none">• May be most feasible to have only the power and caution/warning provisions centralized• Used for storage of toxic materials.	



SORTIE LAB CONTROL/DISPLAY REQUIREMENTS ANALYSIS				SUBSYSTEM/EXP:		Materials Sciences (Continued)	
EQUIP. NO.	SUBSYSTEM PARAMETERS/EQUIPMENT NOMENCLATURE	P/L NO.	EXP.	CONTROLS	DISPLAYS	REMARKS	
S-07	Controlled Atmosphere Fluids Storage (Continued)			Atmosphere supply system on/off Atmosphere supply rate/mix select Atmosphere pressure select Access door open/close actuate (4) Airlock evacuate (2) Material exchange controller (2) Emergency shutdown and sealing	Atmosphere supply system oper. status Atmosphere supply rate Mix pressure Access door open/close (4) Airlock evacuation status (2) Material exchange operating status (2) Leaks detected mal-functions warning	<ul style="list-style-type: none">Assume inner/outer access doors to each of 2 airlocks for the 2 separate chambersSome type of remote manipulator will probably be used for material exchange through the airlocks.	
S-08	Accident Control System	MS-2 MS-3	1,3 2	Master power/pressure shutdown Alarm resets	Power status Pressure status Audio alarm Video alarm	<ul style="list-style-type: none">All other items are either manually operated or constitute personal protection equipment.	

SORTIE LAB CONTROL/DISPLAY
SUBSYSTEM COST SUMMARIES



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: DATA MANAGEMENT			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
TV SYSTEM					
1. TV Monitor, 10" CRT		60#	1500in ³	1000.00	2
2. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none">• Up-on• Center - not wired• Down - off	.135	1.63	15.00	2
3. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none">• Up - zoom in• Center - not wired• Down - zoom out	.135	1.63	15.00	2
4. Toggle Switch, 2 Pos. - Up Momentary	<ul style="list-style-type: none">• Up - grid discharge• Down - not wired (if required)	.135	1.63	15.00	2
5. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none">• Up - pan right• Center - not wired• Down - pan left	.135	1.63	15.00	2
6. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none">• Up - tilt up• Center - not wired• Down - tilt down	.135	1.63	15.00	2
7. Thumb Wheel Pot	<ul style="list-style-type: none">• Focus - center of wheel travel is calibrated with the normal focal point.	.10	1.50	20.00	2
- Focus					
- Brightness	<ul style="list-style-type: none">• Brightness - up or right movement causes brighter display.	.10	1.50	20.00	2
- Contrast	<ul style="list-style-type: none">• Contrast - up or right movement increases contrast.	.10	1.50	20.00	2

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: DATA MANAGEMENT (CONTINUED)			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
7. Thumb Wheel Pot (Continued) - Cross Hair Intensity	<ul style="list-style-type: none"> • Cross hair intensity-up or right movement causes increase in intensity 	.10	1.5	20.00	2
<u>MULTIPURPOSE DISPLAY</u>					
1. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none"> • Up - power on • Center - not wired • Down - power off 	.135	1.63	15.00	1
2. Alphanumeric Keyboard	<ul style="list-style-type: none"> • Allows retrieval of computer stored data using video monitor. 	60#	192in ³	1500.00	1
<u>VOICE RECORDING</u>					
1. Toggle Switch, 2 Pos.	<ul style="list-style-type: none"> • Up - power on • Down - power off 	.135	1.63	15.00	1
2. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none"> • Up - fast forward • Center - not wired • Down - fast reverse 	.135	1.63	15.00	1
3. Toggle Switch, 3 Pos.	<ul style="list-style-type: none"> • Up - record • Center - not wired • Down - play 	.135	1.63	15.00	1
4. Thumb Wheel, Continuous	<ul style="list-style-type: none"> • To right - increases volume 	.10	1.5	20.00	1



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: DATA MANAGEMENT (CONTINUED)			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
5. Fixed Scale, Movable Pointer Analog Meter	<ul style="list-style-type: none"> Upward or right movement indicates increase in volume, scale is TBD. 	.65	16.50	150.00	1
6. Digital Readout, 5 Digits	<ul style="list-style-type: none"> Indicates recording time remaining. 	.75	21in ³	240.00	1
7. Digital readout, 5 Digits	<ul style="list-style-type: none"> Indicates location on tape in units of feet. 	.75	21in ³	240.00	1
<u>DATA RECORDING, ANALOG</u>					
1. Toggle Switch, 2 Pos.	<ul style="list-style-type: none"> Up - power on Down - power off 	.135	1.63	15.00	1
2. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none"> Up - fast forward Center - not wired Down - fast reverse 	.135	1.63	15.00	1
3. Toggle Switch, 3 Pos.	<ul style="list-style-type: none"> Up - record Center - not wired Down - play 	.135	1.63	15.00	1
4. Rotary Switch, 5 Pos.	<ul style="list-style-type: none"> Five record rates will be available. 	.31	1.77	16.00	1
5. Digital readout, 5 Digits	<ul style="list-style-type: none"> Indicates location on tape in units of feet. 	.75	21in ³	240.00	1

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: DATA MANAGEMENT (CONTINUED)			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<u>DATA RECORDING, DIGITAL</u>					
1. Toggle Switch, 2 Pos.	<ul style="list-style-type: none"> • Up - power on • Down - power off 	.135	1.63	15.00	1
2. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none"> • Up - fast forward • Center - not wired • Down - fast reverse 	.135	1.63	15.00	1
3. Toggle Switch, 3 Pos.	<ul style="list-style-type: none"> • Up - record • Center - not wired • Down - play 	.135	1.63	15.00	1
4. Rotary Switch, 5 Pos.	<ul style="list-style-type: none"> • Five record rates will be available. 	.31	1.77	16.00	1
5. Digital readout, 5 Digits	<ul style="list-style-type: none"> • Indicates location on tape in units of feet. 	.75	21in ³	240.00	1
<u>VIDEO RECORDER</u>					
1. Toggle Switch, 2 Pos.	<ul style="list-style-type: none"> • Up - power on • Down - power off 	.135	1.63	15.00	1
2. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none"> • Up - fast forward • Center - not wired • Down - fast reverse 	.135	1.63	15.00	1
3. Rotary Switch, 5 Pos.	<ul style="list-style-type: none"> • Five record rates will be available. 	.31	1.77	16.00	1

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: DATA MANAGEMENT (CONTINUED)				
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD	
4. Digital Readout, 5 Digits	<ul style="list-style-type: none">Indicates location on tape in units of feet.	.75	2lin ³	240.00	1	
<u>EVENT TIMER</u>						
1. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none">Up - provides command to slew the tens digit of the event time hrs. display.Center - not wiredDown - provides command to slew the units digit of the event time hrs. display.	.135	1.65	15.00	1	
2. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none">Up - provides command to slew the tens digit of the event time min. display.Center - not wiredDown - provides command to slew the units digit of the event time min. display.	.135	1.65	15.00		

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST

SUBSYSTEM:

DATA MANAGEMENT (CONTINUED)

NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
3. Toggle Switch, 3 Pos. Momentary	<ul style="list-style-type: none"> Up - provides command to slew the tens digit of the event time sec. display. Center - not wired Down - provides command to slew the units digit of the event time sec. display. 	.135	1.65	15.00	1
4. Toggle Switch, 2 Pos.	<ul style="list-style-type: none"> Up - tone enable Down - tone inhibit 	.135	1.65	15.00	1
5. Toggle Switch, 2 Pos. Momentary	<ul style="list-style-type: none"> Up - start timer Center - not wired Down - stop timer 	.135	1.65	15.00	1
6. Digital Readout, 6 Digits	<ul style="list-style-type: none"> First two digits - hours. Second two digits - minutes. Last two digits - seconds. 	90	24in ³	290.00	1
TOTAL:		191.53	3403.70	5788.00	



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: COMMUNICATIONS SYSTEM			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<u>VOICE TRANSMITTERS</u> - Toggle Switch, 2 Pos. - Rotary Dot, continuous - Press-to-Talk-Switch - Intercom & Speaker System	• Up - ON	.135	1.63	15.00	1
	• Down - OFF	.100	1.50	200	1
	• Clockwise - Increase volume	.850			1
	• Select - Voice transmit	18	320	600	1
	TOTAL:	18.485	323.13	815.00	4

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: POWER SYSTEM			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<u>FUEL CELL INPUT, OUTPUT, INTERNAL TEMP.</u>					
1. Rotary Switch, 12 Positions	<ul style="list-style-type: none"> • Position 1 - O₂ input temp. • Position 2 - H₂ input temp. • Position 3 - H₂O output temp. • Position 4 - internal temp. • Monitor temp. pres. • Up - On Down - Off 	.31	1.77	16.00	4
2. Dual Scale Analog Meter		1.30	33.0	300.00	1
3. Toggle Switch, 2 Positions		.135	1.65	15.00	4
<u>FUEL CELL INPUT PRESSURES</u>					
1. Rotary Switch, 12 Positions	<ul style="list-style-type: none"> • Position 5 - O₂ input pres. • Position 6 - H₂ input pres. 	.31	1.77	16.00	---

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: POWER SYSTEM (Cont'd)			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<u>FUEL CELL FLOW RATES</u>					
1. Rotary Switch, 12 Positions	<ul style="list-style-type: none">● Position 1 - O₂ flow● Position 2 - H₂ flow● Position 3 - H₂O flow	.31	1.77	16.00	1
2. Single Scale Analogue Meter	<ul style="list-style-type: none">● Monitors - flow rates	.65	16.5	150.00	1
<u>FUEL CELL O₂ HEATER</u>					
1. Toggle Switch, 3 Positions	<ul style="list-style-type: none">● Up - ON, Primary Power● Center - OFF● Down - ON, Secondary Power	.135	1.65	15.00	1
2. Mechanical Flag, 3 Positions	<ul style="list-style-type: none">● Bp - Heater OFF● White - Heater command ON, operating temp. not reached.● Gray - Heater at operating temp.	.10	8.5	75.00	1



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: POWER SYSTEM (Cont.)			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
3. Alert Light	<ul style="list-style-type: none"> Light should illuminate when heater fails ON or OFF. 	.03	.01	5.00	1
<u>FUEL CELL H₂ HEATER</u>					
1. Toggle Switch, 3 Position	<ul style="list-style-type: none"> Up - ON, Primary Power Center - OFF. Down - ON Secondary Power 	.135	1.65	15.00	1
2. Mechanical Flag, 3 Position	<ul style="list-style-type: none"> Bp - Heater OFF White - Heater command on, operating temp. not reached. Gray - Heater at operating temp. 	.10	8.5	75.00	1
3. Alert Light	<ul style="list-style-type: none"> Light should illuminate when heater fails ON or OFF. 	.03	.01	5.00	1
<u>FUEL CELL O₂ INLET VALVE</u>					
1. Toggle Switch, 2 Positions	<ul style="list-style-type: none"> Up - OPEN Down - CLOSED 	.135	1.65	15.00	1
2. Mechanical Flag, 3 Positions	<ul style="list-style-type: none"> Bp - Valve CLOSED White - Valve in transition. Gray - Valve in OPEN 	.10	8.5	75.00	1



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM:		POWER SYSTEM (Cont.)			
NOMENCLATURE		REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD	
<u>FUEL CELL H₂ INLET VALVE</u>							
1. Toggle Switch, 2 Positions		<ul style="list-style-type: none"> • Up - OPEN • Down - CLOSED 	.135	1.65	15.00	1	
2. Mechanical Flag, 3 Positions		<ul style="list-style-type: none"> • Bp - Valve CLOSED • White - Valve in trans. • Valve in OPEN 	.10	8.5	75.00	1	
<u>FUEL CELL PURGE</u>							
1. Toggle Switch, 2 Positions		<ul style="list-style-type: none"> • Up - OPEN O₂ and H₂ cell outlet valves. • Down - CLOSE O₂ and H₂ cell outlet valves. 	.135	1.65	15.00	1	
2. Mechanical Flag, 3 Positions		<ul style="list-style-type: none"> • Pb - valve OPEN • White - valve in transition • Gray - valve CLOSED 	.10	8.5	75.00	2	



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM:		POWER SYSTEM (Cont'd)			
NOMENCLATURE		REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD	
FUEL CELL OUTPUT VOLTAGE AND POWER, (28 vdc, 110 vac BUSES)							
1. Analog Meter, Dual Scale, Moving Pointer		● Vertical, linear meter should have range of 0-150v.	1.30	33.0	300.00	1	
2. Rotary Switch, 12 Positions		● Permits display of vdc and 110 vac buses	.31	1.77	16.00	1	
		TOTAL	7.23	160.76	1441.00	26	



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: LIGHTING SYSTEM			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<u>CABIN LIGHTING</u>					
1. Toggle Switch, 3 Positions	<ul style="list-style-type: none">• Up - VARIABLE• Center - OFF• Down - FIXED	.135	1.65	15.00	1
2. Rotary Switch, Continuous	<ul style="list-style-type: none">• Clockwise - BRIGHTER (when toggle switch is in VARIABLE position)	.31	1.77	16.00	1
<u>EXTERNAL LIGHTING</u>					
1. Toggle Switch, 2 Positions	<ul style="list-style-type: none">• Up - ON• Down - OFF	.135	1.65	15.00	1
<u>PANEL LIGHTING</u>					
1. Toggle Switch, 3 Positions	<ul style="list-style-type: none">• Up - VARIABLE• Center - OFF• Down - FIXED	.135	1.65	15.00	1
2. Rotary Switch, Continuous	<ul style="list-style-type: none">• Clockwise - BRIGHTER (when toggle switch is in VARIABLE position)	.31	1.77	16.00	1

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: LIGHTING SYSTEM (Cont.)			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<u>DISPLAY LIGHTING</u>					
1. Toggle Switch, 3 Positions	<ul style="list-style-type: none"> • Up - VARIABLE • Center - OFF • Down - FIXED 	.135	1.65	15.00	1
2. Rotary Switch, Continuous	<ul style="list-style-type: none"> • Clockwise - BRIGHTER (when toggle switch is in VARIABLE position) 	.31	1.77	16.00	1
<u>LIGHTING TEST</u>					
1. Rotary Switch, 5 Positions	<ul style="list-style-type: none"> • Positions: (1) OFF, (2) ATTITUDE, (3) C&W, (4) STATUS, (5) NUMERIC 	.31	1.77	16.00	1
2. Toggle Switch, 2 Positions (One Position Momentary)	<ul style="list-style-type: none"> • Up - MOMENTARY Illuminate light category selected on rotary switch • Down - NOT WIRED 	.135	1.65	15.00	1
TOTAL:		1.92	15.33	139.00	9

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
EXP. ATTITUDE MONITORING					
● Analog Meter, Dual Scale	● Display - CMG: wheel speed temp. amps. ● Momentum - Hx, Hy, Hz, Ht.	1.3	33.0	300.00	1
● Rotary Switch, 12 Positions	● Select - CMG: wheel speed temp. amps. ● Momentum - Hx, Hy, Hz, Ht.	.31	1.77	16.00	1
● Digital Counter, 4 Digits	● Display - Vehicle Att. pitch, yaw and roll ● Star Tracker pitch & yaw. ● Orbital plane error. ● Beta Angle - ΔB. ● Up - star tracker enable ● Center - not wired ● Down - star tracker inhibit	.75	21.00	240.00	1
● Toggle Switch, 3 pos momentary					



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
EXP. ATTITUDE MONITORING (Continued)					
● Toggle Switch, 3 pos momentary	● Up - shutter open ● Center - not wired ● Down - Shutter closed	.135	1.63	15.00	1
● Toggle Switch, 3 pos momentary	● Up - Acq. Auto ● Center - not wired ● Down - manual	.135	1.63	15.00	1
● Toggle Switch, 3 pos momentary	● Up - momentum dump enable ● Center - not wired ● Down - inhibit	.135	1.63	15.00	1
● Toggle Switch, 3 pos momentary	● Up - cage gimbles ● Center - not wired ● Down - release	.135	1.63	15.00	1
● Toggle Switch, 2 pos	● Up - Exp. Ptg. ● Down - off	.135	1.63	15.00	1



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL				
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD	
<u>ATTITUDE CONTROL SYSTEM</u>						
● Toggle Switch, 3 pos. (mom-mom)	● Pitch, yaw & roll.					
● Digital Counter	● Pitch & yaw, manual control of star tracker					
	● Enable/Inhibit	.135	1.63	15.00	1	
	● Display - event time lapsed	.75	21.00	240.00	1	

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<u>EXP. ATTITUDE MONITORING (Continued)</u> ● Rotary Switch, 12 pos.	 ● Select - Vehicle Att. pitch, Yaw and roll. ● Star Tracker pitch and yaw. ● Orbital plane error. ● Beta Angle - $\Delta\beta$.31	1.77	16.00	1



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
EXP. ATTITUDE MONITORING					
● Analog Meter, Dual Scale	● Display - CMG: wheel speed temp. amps. ● Momentum - Hx, Hy, Hz, Ht.	.65	16.50	150.00	1
● Rotary Switch, 12 pos.	● Select - CMG: wheel speed temp. amps. ● Momentum - Hx, Hy, Hz, Ht.	.31	1.77	16.00	1
● Digital Counter, 4 digit	● Display - Vehicle Att. pitch, yaw and roll. ● Star Tracker pitch and yaw ● Orbital plane error. ● Beta Angle - $\Delta\beta$.75	21.00	240.00	1



SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
EXP. ATTITUDE MONITORING (Continued)					
● Toggle switch, 2 pos	● Up - solar inertial ● Down - ZLV	.135	1.63	15.00	1
● Toggle switch, 2 pos	● Up - attitude hold ● Down - Orbiter	.135	1.63	15.00	1
● Toggle switch, 2 pos	● Up - Acq. S. S. ● Down - sun	.135	1.63	15.00	1
● Toggle switch, 2 pos	● Up - Comp. Time enable ● Down - inhibit	.135	1.63	15.00	1

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: EXP. ATTITUDE/STABILITY CONTROL			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
● Rotary Switch, 12 Positions	● Select - Vehicle Att. pitch, yaw and roll. ● Star Tracker pitch & yaw. ● Orbital plane error. ● Beta angle - Δβ.	.31	1.77	16.00	1
ATTITUDE CONTROL SYSTEM					
● Hand Controller, 3 Axis	● Pitch, yaw, & roll.	.95	60.00	2,000	1
● Toggle Switch, 3 Positions (mom-mom)	● Enable/Inhibit	.135	1.63	15.00	1
● Toggle Switch, 3 Positions (mom-mom)	● Up - star tracker ● Down - Exp. Pointing				1
● Toggle Switch, 3 Positions (mom-mom)	● Up - star tracker auto ● Down - star tracker manual	.135	1.63	15.00	1
TOTAL		24.26	198.94	4,749	23

SUBSYSTEM: ENVIR. CONTROL/LIFE SUPPORT

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST

NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
● Toggle Switch, 2 Positions	● Orbiter/Sortie Lab press. equalization on-off.	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Fan, on-off.	.135	1.65	15.00	4
● Toggle Switch, 2 Positions	● Collant, on-off	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Heater, on-off	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Humidity control	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● O ₂ /N ₂ part. press. control, on-off.	.135	1.65	15.00	2
● Toggle Switch, 2 Positions	● Cabin press. relief open-close.	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Cabin temp. bypass open-close	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Collant pump, on-off.	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Bypass, on-off.	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Pump power on-off.	.135	1.65	15.00	1
● Toggle Switch, 2 Positions	● Flow rate control, on-off.	.135	1.65	15.00	1

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: ENVIR. CONTROL/LIFE SUPPORT (Cont.)			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
● Display, Dual Scale Meter	● Temp. in/out and payload temp.	1.3	33.0	300.00	1
● Toggle Switch, 2 Positions	● Temp. in/out.	.135	1.65	15.00	1
● Rotary Switch, 12 Positions	● Payload temp. sel.	.31	1.77	16.00	1
● Display, Dual Scale Meter	● Temp. °F/Re. Hum.	1.3	33.0	300.00	1
● Display, Dual Scale Meter	● PP of O ₂ /N ₂	1.3	33.0	300.00	1
● Toggle Switch, 2 Positions	● Radiator, deploy/retract.	.135	1.65	15.00	1
	TOTAL:	7.28	132.12	1186.00	22

SORTIE LAB CONTROL/DISPLAY SUBSYSTEM COMPONENT COST		SUBSYSTEM: CAUTION AND WARNING			
NOMENCLATURE	REMARKS	UNIT WT.	UNIT VOL.	UNIT COST	NO. REQD
<ul style="list-style-type: none"> Status Lights - 101 Bank 		1.0	17.40	150.00	2
TOTAL:		2.0	34.80	300.00	2